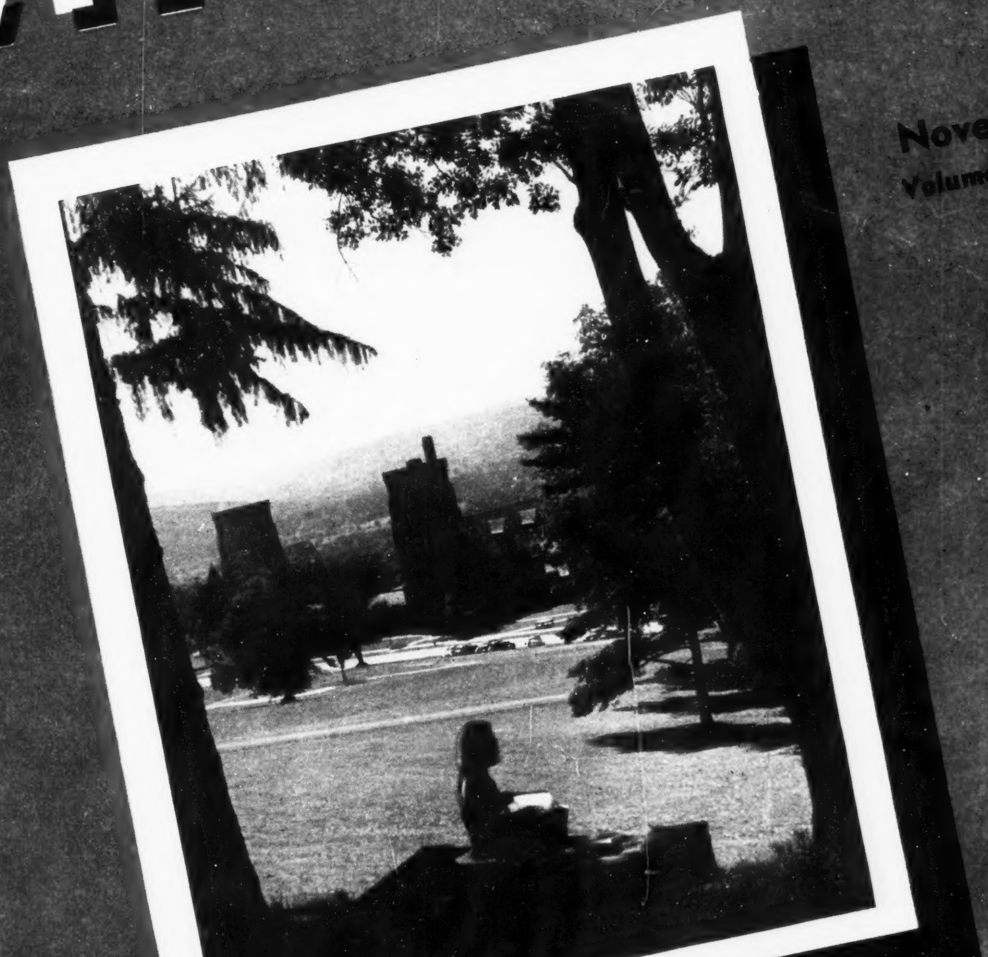
THE CORNELL ENGINEER



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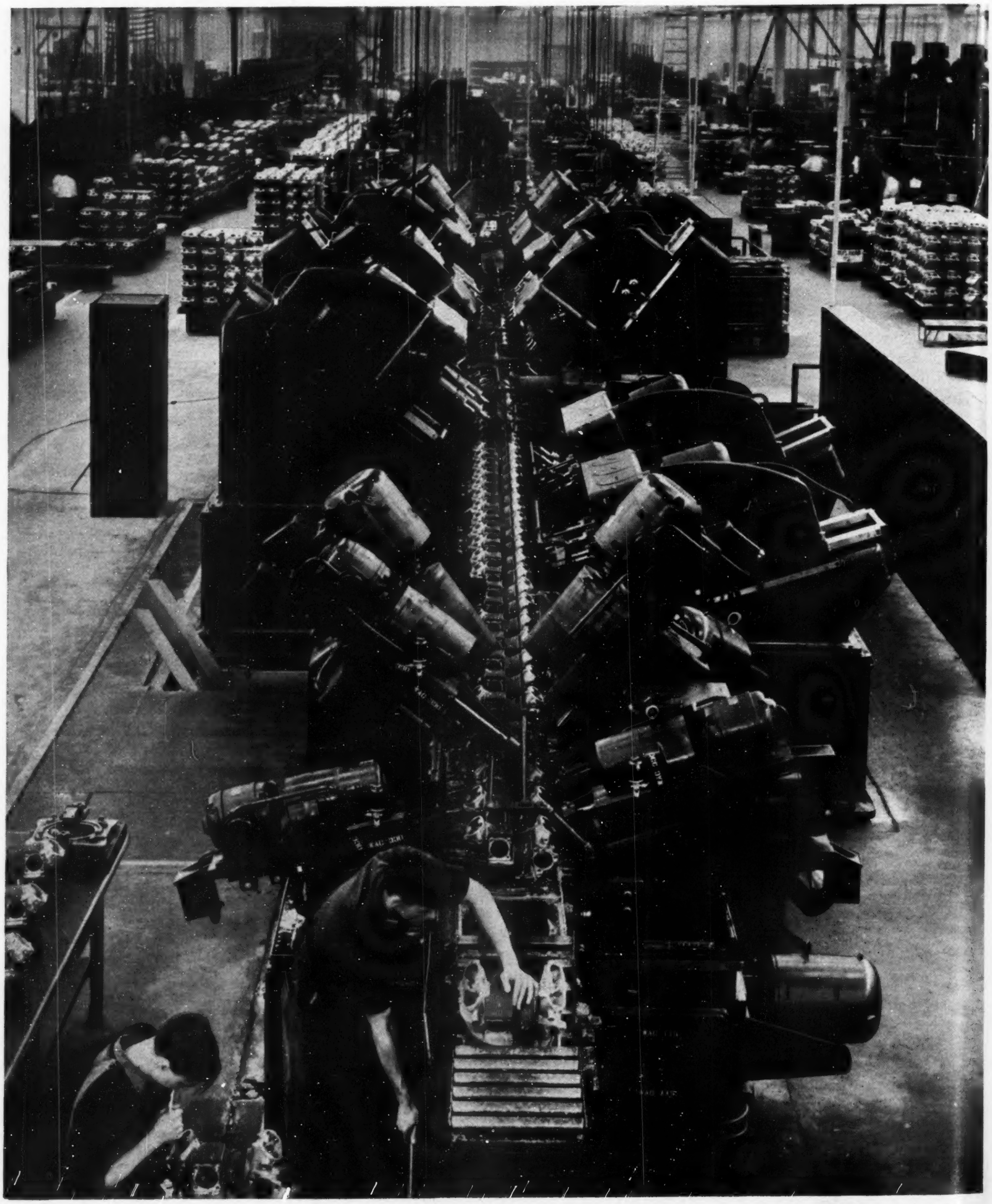


—*Courtesy Wright Aeronautical Corp.*

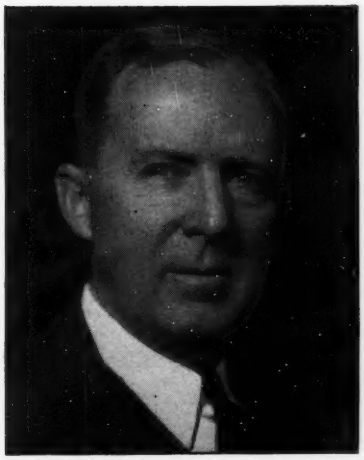
Giant Machine Tool

This huge new machine tool at the Wright plant in Cincinnati is 154 feet long. An engineering marvel, it is designed to drill, tap, bore, face and ream aircraft engine cylinder heads. It is entirely automatic. Operators feed cylinder heads in at one end and take them out at the other. Before this machine was designed, its work was done on 39 separate machine tools. The time saved by the use of this machine is more than half an hour per part. A completed part comes off the line every 48 seconds.

The Post-War Problem of the Machine Tool Builder

By TELL BERNA, M.E. '12

General Manager of the National Tool Builders' Association

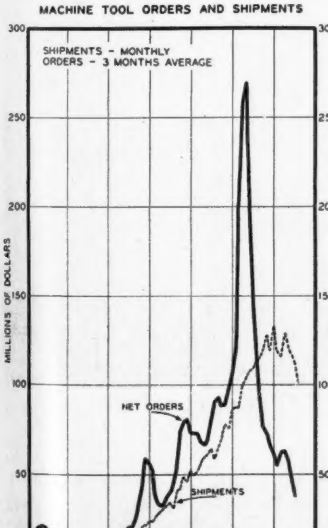


Tell Berna

MECHANIZED warfare, as we are carrying it on today, involves tremendous quantities of war material, and requires development of tremendous production facilities to produce them. The variety of articles that a modern army carries into battle is bewildering. It must have everything from ammunition to zippers. One of the most astonishing achievements in our history is the way in which the products of American industry are being put down behind the battle front, when they are needed, in the necessary quantities, and of satisfactory quality.

Back of this tremendous production is an extraordinary number of machine tools, a quantity of metal-working equipment so large that it is hard for the human mind to conceive it. No one person has ever seen four billion dollars worth of machine tools.

MACHINE TOOL ORDERS AND SHIPMENTS



As one would naturally expect, the machine tool industry was the first American industry to go to war. It was called on by the French and British in 1939 when the gathering clouds that followed Munich induced them to step up their production of airplanes and airplane engines. Our own defense program followed in 1940, and the industry has been vigorously expanding its output since that time. Some types of machine tools are still greatly needed for the Air Corps program; these are known as "critical" machines. But even machine tool builders producing the critical machines are now completing their final expansion.

The shipments of the machine tool industry in a normal year are worth about $100,000,000, while an especially good peace-time year requires an output of $150,000,000.

Compare these sums with the production of machine tools in the United States in the last five years:

	1939	$200,000,000
	1940	445,000,000
	1941	775,000,000
	1942	1,320,000,000
Estimated	1943	1,180,000,000

In the last four years alone, from 1940 to the end of 1943, our total machine tool shipments will exceed those of the preceding forty years. Yet during those preceding forty years the machine tool industry helped to tool up the giant industries of America, including particularly the automobile industry, and to establish mass production of the luxuries of American life, from bobby-pins to radios.

We have accumulated then, by the intense productivity of the past few years, the equivalent of the output of twenty-seven busy peacetime years of metal-working machines. It naturally follows that American industry will enter the post-war period with an unprecedented amount of accurate, modern, highly productive machine tools. Some of them, to be sure, have been shipped abroad, but we will

THE AUTHOR

After twenty-eight years of experience in the management of various engineering concerns, principally in the machine tool industry, Tell Berna became General Manager of the National Machine Tool Builder's Association in 1937. In this capacity, he is in close touch with the plans and activities of the Tools Branch of the War Production Board and with other government agencies in Washington.

Besides his professional activities, Mr. Berna is a member of the Cornell University Board of Trustees.

have in this country by the end of 1943 about three billion dollars worth of machines three years old or less.

Adaptable For Peace-time Uses

It has been suggested that many of these machines will be useless after the war because they cannot be adapted to peace-time needs. This, however, is a misleading statement, for there are very few types of machine tools that cannot be re-tooled or adapted to the manufacture of peace-time products. We won't need very many of the deep hole drilling machines, rifling machines, or gun boring lathes, and there are some other types which we won't be able to use, but the overwhelming majority of the machines can be used as they are or readily retooled.

It is true that these machine tools have been run day and night, six or seven days a week, and have in many cases been operated by half-trained or untrained operators. It must be remembered, however, that the modern American machine tool is built with alloy steel parts, with gears that have ground teeth running in oil, their shafts mounted on anti-friction bearings, their ways in many cases made of alloy steel, and in all cases properly lubricated and guarded; they can therefore stand a great deal of use and even abuse.

This vast accumulation of excellent metal-working equipment is a fine thing for the post-war outlook of the nation, but it poses a very serious problem for the machine tool builder. His war is almost over. He will be expected from now on to furnish machine tools for weapons newly invented or for improvements in old weapons, but the great period of expansion is definitely past. Orders for machine tools in March, 1942 amounted to $367,000,000 and in August 1943, just 17 months later, had dropped to $40,000,000.

The outlook of the machine tool builder is in marked contrast to that of the manufacturer of consumer goods such as automobiles, radios, or domestic refrigerators, who has been unable to satisfy his markets during the war years and will face a tremendous accumulated demand as soon as he is allowed to resume the manufacture of his normal product.

The machine tool builder must take advantage of the declining demand at this time to reduce his inventory of raw stock and finished parts so as to liquidate these assets and end the war with as small an inventory as possible. He must undertake the redesign of his machine so as to make his war-time machine tools obsolete. It is the need for this fundamental redesign, for research, test and experiment, that causes the machine tool industry to be so seriously concerned over the consequence of renegotiation.

Renegotiation Explained

The procedure of renegotiation has been set up by Congress to authorize the Army, Navy, Reconstruction Finance Commission, and the Treasury to review all government contracts not fully paid for before April 28, 1942, and to secure the payment into the Treasury of excessive profits earned on them. Since there are thousands of contracts and sub-contracts, the Government simply reviews a company's total business of a war nature for a year, rather than each transaction.

In theory, the recovery of excessive profits is necessary and no one opposes it. In practice, the procedure has become a witch-hunt resulting in claims for refund of profits that are not excessive. Since the question of what constitutes "excessive profits" is left entirely in the hands of the boards that administer the act, no effective court review is open to the contractor.

The study of one year's operations may be fair if that be a typical year. But there are "feast and famine" industries that must earn high profits in their few good years to offset the losses of bad years. The airplane industry and the machine tool industry are examples. This procedure tends to drain from machine tool companies the reserves that they desperately need to redesign their products and to survive their private depression when the war is over.

It has also been suggested that the market may be cleared of existing machine tools by shipping them to foreign nations that greatly desire to establish their own metal-working industry. A moment's reflection, however, will lead to the inescapable conclusion that the total that can be so disposed of will only be a very small part of our available stock.

It has been suggested that machine tool builders can supplement the manufacture of machine tools by making other products for which

(*Continued on page* 20)

This huge boring mill at the Westinghouse plant was designed specially for machining giant turbines and generators. It is capable of handling work up to 40 feet in diameter. So complex is its design, that its operation requires 34 electric motors. It weighs over 400 tons and costs about $300,000.

—*Courtesy Westinghouse*

Is American Ingenuity Going to Waste?

By JOHN J. BROWN, Ph.D.

Instructor in English, Cornell University

Claiming that amateur inventors don't have the opportunities they deserve, the author suggests a plan for more efficiently tapping our nation's resources of inventive genius.

UNDER the cheering title of "The Flood Tide of Invention", a recent editorial in the New York Times (September 19, 1943) praised the contribution of American inventors toward the winning of the war. Of the 160,000 predominantly amateur inventions submitted to the National Inventors Council in the last three years, three percent have been found worthy of consideration, and many of these are in use by the armed forces. Now these figures, which are quoted with pride, are actually very depressing indeed. They show that in the course of three years the council has received only 4800 **inventions** that were worthy of further notice. In other words, a nation of 130 million people, noted for its ingenuity and mechanical skill, produces sensible non-professional inventions at the rate of only 1600 a year! To describe this meager dribble as a "flood tide" is journalistic optimism at its height. A large, progressive war factory probably receives several times this number of useful suggestions every year.

The reason for the suggestions of workers being predominantly good, and those of amateur inventors being predominantly bad, is not far to seek. The worker is familiar with an actual machine and a practical problem. He sees what is required, exercises his native ingenuity, and produces a new and better method. In many cases he is able to build a sample of his invention and give it an actual trial on his own machine before committing it to the suggestion box. The amateur inventor, on the other hand, has none of these advantages. He studies the problem, and has an idea about how it might be overcome. But it is only an idea, and in mechanical things, ideas alone are worthless. Any factory production man will speak feelingly about the "scratch-pad engineer"—the man who has bright ideas, but who leaves it to someone else to iron out the bugs and actually build the idea into a product. Factories produce practical inventions because each idea is worked over at length by practical engineers and technicians until its superfluities and absurdities are purged away. This process takes time, money, and expensive measuring and construction equipment; and of these, the private inventor has only the first. It is apparent that the vast majority of our amateur inventors are merely scratch-pad men, and it is hard to see how, under the present system, they can be expected to be anything else. Although they have ideas in abundance, they have no means of embodying them in actual apparatus, and no measuring equipment to test the apparatus even if built.

The 155,200 inventions rejected by the National Inventors Council were no doubt childish and fantastic, provocative of both laughter and tears. But this frightful rate of 97 percent rejections does not represent the calibre of American inventors, but rather shows how sadly the ingenious Yankee has been hamstrung by an outmoded system. The American worker is still ingenious enough—the packed suggestion boxes in the factories show this—but, lacking precision tools and accurate measuring equipment, he is incapable of serious contributions on the higher level.

Typical Example

Although it is dangerous to draw general conclusions from a single case, my experience in the engineering department of a manufacturer of electronic devices is perhaps typical. Almost without exception, the engineers with whom I worked had some pet invention of their own. One had a method of controlling the angle of attack of airplane wings; another had a plan for taking true stereoscopic motion pictures; a third had developed a radically different kind of heat engine which would develop three times the power of a gasoline engine on a given amount of fuel, yet at the the same time required no cooling system. All these devices looked good on paper, but under present conditions, they are likely to remain undeveloped for some time.

The engineering department was full of good equipment which we were free to use for our own projects after working hours, but since we had already signed over to the company all rights to any discovery we might make, the incentive to work overtime was lacking. These men had equipment available, but ran into legal difficulties which prevented its use. Most amateur inventors, however, seldom get with-

in hailing distance of precision equipment.

In my own mildly inventive work in sound recording on acetate tape, I have usually been fortunate in securing the use of good machines, but this was not done without some persuasive oratory, for machinists are understandably reluctant to entrust a three thousand dollar lathe to a stranger. As a Cornell faculty member, I have come to know which departments have good machinery available, and, after more or less extended negotiations, have usually found a sympathetic director who would allow me to use it. But the average man with an idea on paper does not have this advantage. Since he neither knows where machinery is available nor has any idea of how to begin negotiating for its use, he is doomed to see his idea remain on paper indefinitely, and perhaps never to know whether or not it was practical.

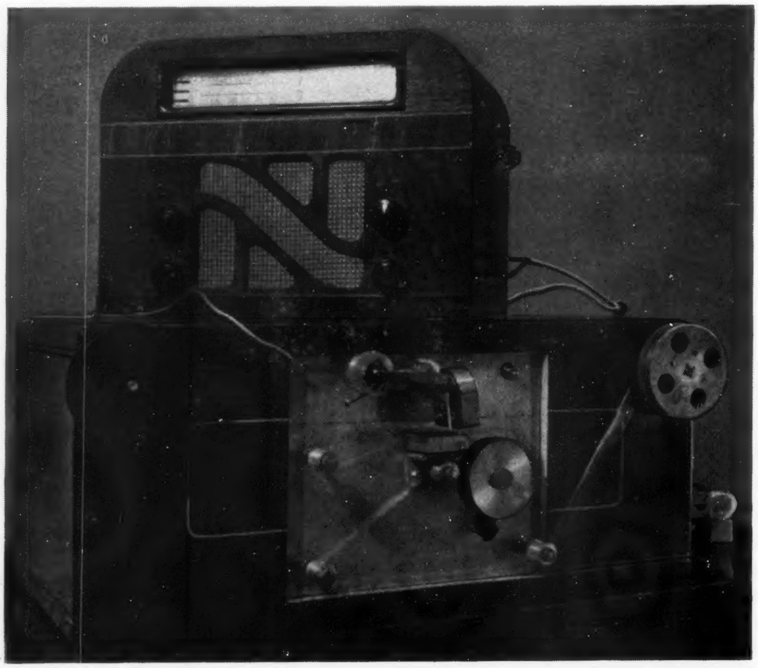


Figure 1. A high-fidelity acetate tape sound recorder built by the author.

Research Has Grown Up

Our old free enterprise system worked very well in the early days of technological advance. For instance, when Edison was making his discoveries in electricity, any ingenious person could experiment with odds and ends of equipment found in the barn. When radio research was in its infancy, almost any man who crossed two wires by accident had discovered a new circuit. A glance at the wording of many of the early vacuum tube patents is enough to convince one that the inventors had no idea of what they had done. Invention was then in its most primitive stage, and any wood butcher could build equipment which worked reasonably well. Although this stage was reached at different times in different fields, it is certain that in our day we are far beyond this stage in every branch of science. Today, in building new mechanical equipment, tolerance must be held to at least a thousandth of an inch, and frequently to a ten thousandth. Electronic research tends to become more and more meaningless unless one has precise and versatile measuring equipment, and this is beyond the reach of the private investigator. Similarly in all fields of inventive effort, the great extension of knowledge has tended to drive the small man to the wall.

Thus it comes about that discoveries of our day tend to come from the research laboratories of the large companies who can afford to buy materials and equipment. These companies are business enterprises first, and cultural and patriotic enterprises second, and with them a basically new invention cuts both ways. A great invention nearly always involves scrapping literally millions of dollars worth of equipment, and no wise business man does this with alacrity. Hence inventions from the large research laboratories have a habit of getting lost in the files, and remaining there for years. Not only do consumers lose by this, but when a war comes, it often finds us unprepared.

Phonograph Records Obsolete

A specific example of how, through lack of competition among inventors, important discoveries are sometimes shelved, might be taken from my own field of sound recording. It is common knowledge that the shellac discs sold with ecstatic advertising claims are hopelessly obsolete. Yet because of money invested in equipment, they continue to be manufactured and sold. The vogue of the midget radio has conditioned the music-loving public so that most people are incapable of appreciating true high fidelity. As a result, an ordinary record of a symphony, with its range of 40 to 3000 cycles per second, sounds good enough to them. But there are devices extant capable of recording everything from 20 to 16,000 cycles per second—devices which, when heard, give the listener the impression that he is standing in the middle of a large symphony orchestra.

Whether or not we have lost our taste for true fidelity of tone, there is no doubt that everyone hates the nuisance of getting up every four minutes to change the record. There are several simple ways of avoiding this difficulty, but they all involve scrapping a large investment in disc record making equipment. Since the record business, in its present highly lucrative form, must survive at all costs, the manufacturers have gone to great lengths to take the nuisance out of playing records. They have evolved some beautiful (and expensive) mechanisms which, if all goes well, will provide a full hour of music, with only a few seconds of grind and scratch between each selection. But these are merely stopgap devices, developed to save the 40 million dollar record industry, not to give the consumer better music in the home. In a recent article in *Electronics*, a trade magazine for the radio industry, the

situation is very neatly summarized. After going over the various kinds of recording devices—the magnetic tape, the continuous acetate strip, the slow speed phonograph—the writer goes on:

> "These are very satisfactory for certain specialized uses such as broadcast and business conference applications. For the mass home market, however, reasons of economy and conditions of the phonograph market rule them out."

Economy certainly cannot be a reason for avoiding acetate tape, for materials for recording a 40 minute symphony on it cost one fortieth of the price of an album of shellac discs (Figure 1.) Many of these new devices are actually less complicated than automatic record changers, and could be mass produced at a reasonable price. It is these "conditions of the phonograph market" that really prevent progress in the recording field. What this euphemistic phrase means is that since the record companies have invested their money in an obsolete method, they must defend that method at any cost.

Progress In Other Countries

Western Electric was known to be experimenting with continuous acetate tape recording in 1930, but for some reason the idea was dropped. Yet in 1939 the Japanese came out with a commercial recorder of this type, which apparently had great success. It seems strange that with our magnificently equipped research laboratories all over the country, we should nevertheless be behind most other nations in the recording field. The theory of magnetic tape recording has long been known, but experimenters have been stopped by the problem of making the tape hold its magnetism over a period of time. This would appear to be a relatively simple metallurgical problem—one which could be solved if the companies were really interested in a solution. But next to nothing was done, or at least announced, in America. Germany, however, was producing magnetic tape recorders commercially before 1938, and when the war came had thousands ready for important military service. We, on the other hand, had to conduct a feverish search through our files, redesign the magnetic recorder on modern principles, and painfully iron out the inevitable difficulties connected with the mass production of a new item. Only now, after four years of war, is our version of this instrument seeing action at the front (Figure 2). My point at this time is not only that the tactics of the record companies deprive the consumer of the benefits which science is equipped to give, but also that their failure to develop the new recording methods commercially has left us at a disadvantage in time of war. A manufacturer, under our free enterprise system, has a perfect right to suppress any discovery which will work to his disadvantage. On the other hand, the soldier at the front has the right to demand all the mechanical and electronic helps that modern science can provide.

One solution to this problem would be for the government to encourage free competition in invention. Give the average ingenious American some equipment, and he will be able to make distinctly valuable contributions to the nation's welfare. He has the leisure, he has the talent—all he needs is equipment. A surprising number of discoveries about radio have come from the lowly "hams," with their brainchildren made of pieces of discarded receiving sets, and their erratic and inaccurate homemade measuring equipment. One has to be born a magician to make discoveries with this sort of apparatus; yet it has been done. How much more, then, would be accomplished, if our amateur inventors were provided with precision machine tools, and professional measuring equipment.

Figure 2. Colonel E. M. Kirby of the Army Public Relations Bureau lifts a nine-pound magnetic wire sound recorder being built by General Electric for the armed forces. A combination recording and playback unit can be seen behind the smaller instrument.

Use Existing Clubs

The task of providing such workshops is relatively simple because in most cities the machinery for organization is already set up. The American Radio Relay League has ample enthusiasm, an official organ published monthly, and a membership that runs into tens of thousands. Almost every city has a branch of the Society of Model Engineers, with a clubroom, and sometimes considerable equipment. But these and many similar organizations are grievously hampered by lack of funds, and they must have help from the government before their potential value to the country can be realized. The plan might be worked out something as follows. Beginning with organizations which already have a large membership and a means of publicity, let the government deposit in their clubrooms the three essentials: recent technical books, basic machine tools, and precision measuring equipment. This property should be placed under the control of a committee elected annually by the members of the club, but any resident with bona fide non-commercial projects to be worked out would be free to make use of it. A piece of apparatus would be assigned for two-hour periods, just as darkrooms are alloted in camera

(*Continued on page* 26)

The Amplidyne—what it can do and how it works . . .

Dynamo with a Brain

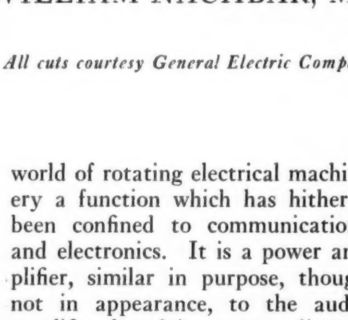
By WILLIAM NACHBAR, M.E. '44

All cuts courtesy General Electric Company

WITH the latest developments of combat and production the topic of scores of movies, and newspaper and magazine articles, John Q. Public has been thoroughly captivated by the most spectacular developments of engineering science. Catchy names like Radar, television, helicopter and electronics, formerly spoken of only in the solemn tones of the scientist, are now common conversational topics. The man of the future is confidently expected to drive about in his beetle-shaped car, powered by a shoe-box sized gasoline turbine which operates on a saucerful of high octane fuel per week. He will cook his food by induction heating, live in a spun glass and nylon house, and have his privacy guarded by photo-electric eyes peering from every doorway and crevice.

There are, however, other developments equally as intriguing as the fireless stove or beetle car, which have lain unlauded by the Sunday supplements. These are confined more or less to the industrial rather than the domestic picture, and they promise miracles in high production figures and low production costs. One of these devices, introduced in the past few years, has accomplished nearly impossible tasks in many industries, has helped to speed war production and to break important bottlenecks. It has already carved its niche into the Nazi tombstone by giving to the bomber turrets their deadly accuracy against swift enemy planes. The name of this phenomenal instrument is also one for the science-minded to conjure with—the Amplidyne.

The Amplidyne introduces to the world of rotating electrical machinery a function which has hitherto been confined to communications and electronics. It is a power amplifier, similar in purpose, though not in appearance, to the audio amplifier found in every radio set. Unlike its electronic cousin, whose output is but a few watts, the Amplidyne handles power in industrial quantities, ranging into many kilowatts, controlling it with amazing rapidity and with the expenditure of less than a watt in its own control circuit. Typical Amplidynes have amplification factors, ratios of control power to output power, of about 10,000 to 1; their full required output may be reached



Dr. E. F. W. Alexanderson, who helped develop the Amplidyne

in 1/10th of a second, and they vary their output at the remarkable rate of 2000 volts per second.

Aims Gun Turrets

How is a power amplifier of such unusual properties as these employed? Examine first the case of the bomber turret. The gunner, operating the turret mechanism through its motor controls, must aim the turret in order to aim his guns. The turet is a massive piece of equipment; in addition it is operating against the force of a three-hundred mile per hour air stream. This force may be aiding turret motion in one portion of the arc of travel and opposing the motion in another position. In spite of this, the turret motor must at all times be in positive control of the turret motion. The turret must start, stop, or reverse direction instantaneously according to the gunner's wishes, for the slightest delay or lag in control action might endanger the entire ship. This is a large order, but the Amplidyne, with its ability to translate delicate electrical signals swiftly into surges of power, and to maintain constant speed under any variation of torque, is able to fill the bill.

Industry has seen many examples of Amplidyne magic, for this device helped to double the cold-rolled steel plate production of the country in the short space of one year. It enabled hot strip mills, formerly used for rolling thin sheet steel for automobile bodies, to be pressed into service as plate rolling mills and thus break the armor and ship's plate bottleneck. With Amplidyne control, motors which were formerly driving continuously running tables delivering strip steel to the coilers, were converted to the intermittent starting and stopping of the rolling operation. Amplidyne control has meant operation at peak motor capacity, using maximum rates of acceleration and deceleration, utilizing available motors at their peak capacity, and insuring maximum tonnage production.

Amplidyne control has introduced faster, more accurate operation in strip mills where flying

shears crop the steel strip at strip speeds of 2000 feet per minute. Speed regulation and coordination between the several mill stand motors and the shears, through the sensitive yet powerful controlling action of Amplidynes, has meant highest production efficiency and output with no sacrifice of quality. Both high and low mill speeds are held accurately to a few percent of the limit.

Amplidynes have been applied extensively to machine tools, positioning the cutting heads on a boring mill, for example, to an accuracy of .002 inches per ten foot travel. Maximum acceleration is provided on the return strokes of reciprocating machinery; on one installation in a saw mill carriage, the total round trip time for a 30 foot travel was cut to an unbelievable 4½ seconds.

The accurate and rapid positioning of a material speeding through a machine is a difficult problem which Amplidyne control has solved. Side register control of a paper machine is typical. In this set-up a photocell scans the edge of the paper sheet being reeled. Any tendency of the paper to move out of alignment causes the photocell to transmit an electrical signal to the Amplidyne, which then operates the motor controlling the alignment of the reel to bring about a correction. An accuracy of 1/100th of an inch is maintained in controlling the position of the edge of the paper, despite the fact that the paper may move the entire width of the accuracy zone in 1/100th of a second.

Many Other Uses

Amplidynes maintain constant tension on wire reeling machines throughout a wide speed range. They automatically position the electrodes of an arc furnace to produce a uniform heat under a wide variation of conditions. They control motors on giant power shovels to deliver maximum rates of acceleration and deceleration under heavy operation, yet they guard against overloading of the machines. These examples and scores of others illustrate the success of the Amplidyne in every industry to which it has been applied.

What is the Amplidyne? A first look at this equipment would probably excite no gasps of amazement, for in its outward appearance, it closely resembles the ordinary, externally driven, d.c. generator. By use of a pair of short circuited brushes and a special compensating winding, however, the sluggish character of the conventional machine is transformed into the trigger speed of the Amplidyne.

For purposes of comparison, let us examine a conventional two-pole d.c. generator. This machine has a field structure composed of many coils of current-carrying wire wound around stationary iron core poles attached to the rigid framework. These coils produce a magnetic field whose flux crosses the armature between the two poles. The armature, on which are wound other coils of wire, is rotated by a prime mover. The rotating conductors in the magnetic field have induced in them an alternating voltage. Brushes, set on a commutator in the middle of the magnetic field, rectify this voltage, and when a resistance load is connected between the brushes, direct current flows through the armature coils and the external circuit.

The armature current flowing through the armature coils sets up a stationary magnetic field of its own. This flux, under rated conditions of generator operation, is about equal to the field coil flux but acts at right angles to this flux and hence has only nuisance value.

The output of the conventional generator is governed by varying the value of power-generating flux in the magnetic circuit of the machine. A motor might be controlled by varying the field of a conventional generator whose output supplies motor field excitation. This method is never used, though, where accuracy or speed of control are required. The reasons are twofold.

This huge shovel's dipper holds a freight-car load of dirt. By using Amplidyne control, it can scoop up its burden in only 50 seconds time. It is used in open pit mining of coal. Note the men on top of the cab.

First is that the sensitivity, accuracy, and speed of response of a measuring device, down to certain limits, is inversely proportional to its power rating. Photo-electric relays, vacuum tubes, limit switches and high speed electro-mechanical relays of all types are very low power devices which deliver a signal in the neighborhood of 1 watt. As the field circuit of even a small size d.c. generator uses power measured in hundreds of watts, it can hardly be expected to vary gen-

erator output in any practical range from the signals of these small power control devices.

Secondly, the large number of windings of the generator field coils cause a high inductance and a large time constant for the field of the conventional generator. Thus there is always a considerable delay between the change in field voltage and the corresponding change in generator output. This delay, although measured in seconds and hardly discernable to the observer, would be intolerable in a case such as that of the paper reeler where correction must be applied within a minute fraction of a second after misalignment has occurred.

For operation in control circuits, the conventional generator must be altered so that the control field excitation power is reduced to about a watt for all sizes of generators, while the generating flux and the power output of the generator remain the same as before. This alteration is the secret of the Amplidyne.

How It Works

Consider a conventional generator of 10 kilowatts output being operated at rated speed with 100 watts field power producing a full load voltage of 100 volts. The load resistance is one ohm and the full load current in the circuit is 100 amperes. Reduce now the size of the field coil so that excitation power is lowered from 100 watts to 1 watt. The new excitation creates only 1% of the original exciting flux, and hence voltage is reduced from 100 volts to 1 volt. The load current, reduced from 100 amperes to 1, now produces only 1% of the former armature flux. One objective has been obtained, as we now have excitation power reduced to a value where it can be readily supplied and handled by precise control devices. How can we restore full-load working flux and yet retain this low excitation power?

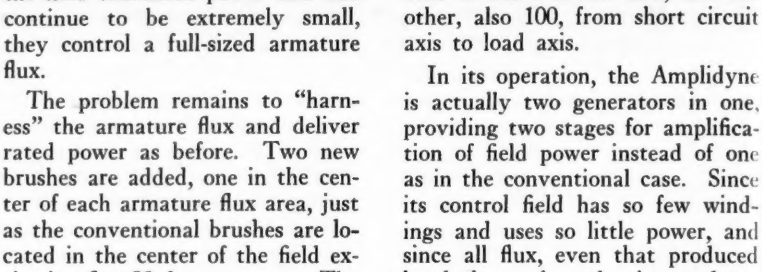
The load is next disconnected and the brushes short-circuited. If we assume the internal resistance of the armature circuit and brushes to be 1/100th of the load, the reduced voltage of 1 volt produces the rated current of 100 amperes. Armature flux has now been restored to its full value, and although the field excitation power and flux continue to be extremely small, they control a full-sized armature flux.

The problem remains to "harness" the armature flux and deliver rated power as before. Two new brushes are added, one in the center of each armature flux area, just as the conventional brushes are located in the center of the field excitation flux 90 degrees away. The new armature flux is full-sized and so produces 100 volts, full voltage, between the new brushes. These new brushes are connected to the load, and they deliver the full load current of 100 amperes as before. In the same armature conductors, the new load current adds to and subtracts from the short circuit current. This is the Amplidyne.

The new armature current tends to set up its own armature flux in the same magnetic axis as the control field coils, where it would buck the control field and overpower the small control flux. Hence a compensating field winding is placed around the control field pole pieces in series with the load to neutralize this tendency.

Assume that the excitation current is suddenly doubled (an increase in exciting power from 1 watt to 4). This instantly doubles the short circuit current, producing double voltage (200 volts) and double load current (200 amperes). Thus by raising the control input 3 watts, the output is increased from 10 kilowatts to 40. A power amplification of 10,000 is thereby obtained in two stages; one amplification of 100 from control field coils to short circuit axis, and the other, also 100, from short circuit axis to load axis.

In its operation, the Amplidyne is actually two generators in one, providing two stages for amplification of field power instead of one as in the conventional case. Since its control field has so few windings and uses so little power, and since all flux, even that produced by leakage through air, produces useful voltage, the Amplidyne's response time for the two stages is much less than that of the conventional one stage.



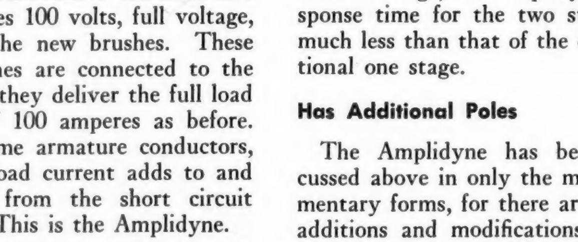
This diagram shows how one amplidyne can replace two ordinary generators.

Has Additional Poles

The Amplidyne has been discussed above in only the most elementary forms, for there are many additions and modifications which can be made to bring out further characteristics. These machines usually have more than the one pair of poles, but the additional poles do not alter the theory. Because of the small size of the control windings, multiple field windings responding to the signals of independent control devices may be placed on the field structure, the Amplidyne responding to the resultant action of the several coils. The ordinary Amplidyne has a complement of four of these fields. These occupy so little room, however, that the field structure for the machine is no larger than that for a conventional generator of the same rating.

Amplidynes are usually about 25% larger than conventional ma-

(*Continued on page* 32)



Where a large motor is needed, it is common to use the Amplidyne to excite the field of a larger generator, which in turn supplies the motor.

NEWS OF THE COLLEGE

ESMWT

THE ESMWT last month inaugurated a new course for the Ithaca area in industrial safety engineering. Designed to aid war industries in increasing production by training supervisors in accident prevention and maintenance of proper health conditions in factories, the course is a part of a countrywide program of safety engineering which is being supported by the National Safety Council, the American Society of Safety Engineers, the National Committee for the Conservation of Manpower in War Industries under the Department of Labor, and other organizations.

This course is one of nine being given this term under the Engineering, Science, and Management War Training Program. Others include engineering mathematics, engineering calculus, fundamentals of radio, time and motion studies, cost accounting for war production, engineering electronics, and ordnance material inspection.

Dr. George R. Hanselman, associate professor in the College of Engineering, addressed the Binghamton Chapter of the National Association of Cost Accountants recently in the Arlington Hotel. His address was on the Training of Accountants under the Engineering, Science, and Management War Training Program.

Dr. Hanselman has had charge of three accounting courses offered in the Southern Tier under ESMWT program in the past two years, and has acted in an advisory capacity for others.

Enrollment

A list of the number of engineering students registered in the University this Fall term has been recently released. The list showed a total of 1707 students of which 1084 were V-12 trainees and Marines, 577 were civilians, and 46 members of the advanced ROTC.

By schools the figures are: Administrative Mechanical 79, Chemical 290, Civil 257, Electrical 339, and Mechanical 742. There are 255 entering freshmen altogether.

Also being trained by the engineering schools are close to 300 student officers in the steam and Diesel engineering programs and more than 100 Curtiss-Wright cadettes.

The following were elected on Nov. 9 to the CORNELL ENGINEER staff:

Editorial

James Edison, ChemE '46
Adam Friederich, CE '47
Robert Goldman, EE '47
Marguerite Haven, ME '46
Elias Hoffman, ME '47
Richard Horowitz, ME '47
Mary Martin, Curtiss Wright
Herbert Meltzer, CE '47
William Nachbar, ME '44
Murray Rosenblatt, EE '47
Diana Silver, EE '47
Ernest Sternglass, EE '44
Jacques Zakin, ChemE '47

Business

Calvin Brown, CE '45
Charles Kerby, CE '45
Samuel Lewis, ME '47
Bernard Rodier, A '45

Chi Epsilon

THE last meeting of Chi Epsilon, honorary CE society, for the summer term was held at Lincoln Hall on October 13. The purpose of the meeting was to elect officers and to plan the activities of the society for the fall term.

The officers elected were Robert Benscoter '44, president; Donald Smith '45, vice-president; Charles Kerby '45, secretary-treasurer; and William Zuk '45, associate editor of *The Transit*, organ of the society.

W. A. Lewis Leaves

DR. William A. Lewis, Jr., director for the past five years of the School of Electrical Engineering, is leaving this position on December 1 to return to the field of engineering research. Formerly an engineer with the Westinghouse Electric and Manufacturing Company in Pittsburgh, he was appointed director on January 21, 1939, on his thirty-fifth birthday, this making him one of the youngest men ever selected for such a high administrative office at Cornell. He is returning to the field of his special interest, technical work and research, for which he has had little time because of his administrative duties here. Dr. Lewis is taking positions as research professor at Illinois Institute of Technology and consulting engineer to the Armour Research Foundation.

Commenting on his departure, Dean S. C. Hollister said: "We greatly regret losing Dr. Lewis. He has contributed much to Cornell and has greatly advanced the work of the School of Electrical Engineering. In the field of research, to which he returns, Dr. Lewis can be expected to make notable contributions, and we all look forward to his continued success and advancement in the field of electrical engineering."

During Dr. Lewis' tenure at Cornell, the new $150,000 high voltage laboratory was erected in cooperation with insulator and cable manufacturers for fundamental research in the field of high voltage practice.

Also during his term of office the junior electrical laboratories in Franklin Hall were reorganized and rebuilt for greater serviceability to both teachers and students. There are now about twice as many members of the teaching staff as when he came, the increases being caused primarily by the large number of men in the steam and Diesel engineering programs of the Navy who take courses in electrical engineering.

Dr. Lewis, a native of Harriman, Tennessee, received his BS with honor at California Institute of Technology in 1926, his MS with honor in 1927, and in 1929 was the only student ever to receive from that institution the Ph.D., summa cum laude.

(*Continued on page* 32)

ALUMNI NEWS

Bazooka

The much-acclaimed "bazooka" gun, terrible and mysterious weapon which played such a major role in the defeat of "Desert Fox" Rommel in the North African campaign, is the product of the inventive genius of Jacob Yavitch, M.E. '28. Of the "bazooka" the Chief of Ordnance of the United States Army has said that it is so simply operated and yet so powerful that any soldier on foot can stand his ground with the definite knowledge that he is master of any tank which may attempt to attack him.

The device was conceived while Mr. Yavitch was employed as Associate Mechanical Engineer in the Cannon and Munition Department of the Munitions Development Division of the Chemical Warfare Service. The Chief of Chemical Warfare Service addressed a letter to the munitions division in February of 1942, stating that a self-propelling projectile was being experimented with at California Institute of Technology in collaboration with the National Research Council. The problem, which Mr. Yavitch soon solved, was that of devising a gun to fire this projectile.

Since the projectile had a tail designed to stabilize its flight, the barrel of the gun would not be subjected to the tremendous wear inherent in the rifling action necessary to give most shells their direction. It seemed logical, then, that the new gun need be made only of very thin material, about three-sixteenths of an inch. Mr. Yavitch put a battery on the side of the tube to set off the charge in the self-propelling shell, designed the tube like a telescope so that it could be pointed in any direction at will, and his job was ended. Or had it only just begun?

Army officials were painfully incredulous. A simple tube to fire so powerful a projectile? Nonsense! The recoil would knock any soldier flat on his back. "The nice thing about the recoil in this gun," explained the designer, "is the same thing that is nice about carrots in chicken salad. There is none." Superiors contemptuously dubbed the instrument "Yavitch's Telescope" and gave it no more thought.

Jacob Yavitch

But in April, at the testing grounds at Edgewood Arsenal, ten miles from Aberdeen Proving Grounds in Maryland, high-ranking officials saw the charge ignited. They saw the shell scream forth with the peculiar hissing sound that has terrified hordes of Germans. "Yavitch's Telescope" stood firm. There was no recoil.

From that point on, Mr. Yavitch knows little more of the history of his telescope than the average civilian. Some time after the Edgewood Arsenal test, he recognized in the "bazooka" gun the very mechanism which he himself had designed.

Mr. Yavitch, having been born in Russia and having there undertaken his early studies, came to Cornell and graduated from the College of Mechanical Engineering in 1928. Following graduation, he was at various times in the employ of Westinghouse, General Electric, American Locomotive, General Motors, and Grumman Aircraft. In 1933, he returned to Cornell to obtain his masters degree in Mechanical Engineering, majoring in the Mathematical Theory of Lubrication. "Pressure Distribution in a Complete Cylindrical Bearing" and "Lubrication" were two of his contributions to the *Sibley Journal*, predecessor to the CORNELL ENGINEER. Today Mr. Yavitch is Assistant Professor of Mechanical Engineering at Villanova College.

During recent operations in Africa, a small but strong fort gave considerable trouble to the American forces. One lone American soldier detached himself from the landing party, waded ashore, and with one shot from his weapon effected the surrender of the fort. That will be known as the saga of one American soldier and his "bazooka".

Army-Navy "E"

Several companies with Cornell alumni as officers have received distinguished Army-Navy "E" awards within the past few months.

The Metal Specialty Company was presented with the award on the twenty-fourth of June, H. S. Johnson, C.E. '11, being vice-president and general manager of the company.

On September 28, Burlington Mills, Inc., of Burlington, Wisconsin, won the same award. George C. Salisbury, M.E. '12, is vice-

(*Continued on page* 24)

CORNELL SOCIETY of ENGINEERS

107 EAST 48TH STREET, NEW YORK 17, N. Y.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

Fellow Engineers:

Our Committee on Equipment for the College of Engineering is being formed and its membership will be increased as the scope of our activities is broadened.

As previously pointed out, the machine tools and equipment to be acquired for our shops and laboratories will be found in plants largely engaged in the production of war material and supplies and consequently will not be available for any other purposes until after the cessation of hostilities.

The greater portion of the tools and equipment employed in war production is likely to be wholly owned by government and its after-war disposition controlled and administered by government agencies.

In due time, these agencies might be expected to prepare and publish lists of such surplus items as the government wishes to release, including their identifying specifications. These items, if to be acquired for educational purposes, presumably would be sold at a nominal price. But the time element involved in the preparation and circulation of government lists, the possibility of prior acquisition of what we want by others, and the lack of time for proper inspection, suggest the desirability of planning for earlier possession through knowing just what we want and where it is located. Such planning also affords the prospect of finding what surplus items we want in privately owned war plants from which acquisition might be realized through gifts.

We have received from Dean Hollister a preliminary list of machine tools needed for our shops. Mr. Tell Berna plans to describe each type of required machine by size, capacity, rating, etc., listing the major accessories that should be furnished with it. It has been agreed that the condition of the machine and of the accessories accompanying it is of greater importance than the make of the machine. As a general rule, there are many excellent makes of the same type of machine tools. So much of what we want has been manufactured since July, 1940, that we should be able, notwithstanding assumed twenty-four hours per day operation since then, to satisfy our needs with machines that are in prime physical condition.

List To Be Kept On File

As complete and fully descriptive lists are prepared for our use, copies will be sent to each member of our Committee on Equipment for the College of Engineering, and to each of the regional offices of our Society. A file will be available at all times in the New York office.

Every Cornell engineer with whom I have discussed our undertaking endorses it, because he knows Cornell's needs. Furthermore, they all want to help.

We must bear in mind that there will be stupendous efforts by government and industry to utilize war plants and facilities to the utmost for the production of peace time goods, in order to cushion the impact on our economy resulting from the demobilization of our armed services and the release of millions of workers from war industries.

The Committee on Economic Development, the Committee on Utilization of War Plants and Surplus Property formed by the U. S. Chamber of Commerce, the War Production Board, the Office of War Mobilization, and many other groups are interested in keeping the wheels turning during that period of transition from war-time to peace-time economy.

All of these praiseworthy efforts may very properly delay the determination of availability of certain types of equipment, but it would seem that, considering the prodigious output for war purposes, there will nevertheless be vast surpluses of good machine tools for laboratory equipment.

At a meeting of our Society to be held at the Cornell Club in New York City on Friday evening, December 3, we hope to have Dean Hollister, Dean Emeritus Kimball and Tell Berna discuss this undertaking with us, with the idea of evolving a procedure embodying the most direct and practical approach to the handling of the enterprise.

All Cornell engineers, both members and non-members of our society, are urged to join in this program. We want your comments, suggestions and criticisms, so as to do the very best job possible.

Cordially yours,

JAMES LYNAH, '05

"Loose Juice"

Bull System Practices
Apparatus Development Section
Provisional Standard Z-00001006

(*Reprinted through the courtesy of the American Telephume and Telegrab Co.*)

NUMBER 2-B REGRETTOR
DESCRIPTION AND PROCEDURES

1. General

1.11 The No. 2-B Regrettor is a light weight, compact unit, recently developed specifically for use by persons whose capacities for regretting are below normal, or who, due to various activities, have more to regret than can be conveniently handled without artificial aid.

1.12 Through the use of this device it is possible for the user to have his bad moments regretted for him, and he is meanwhile left

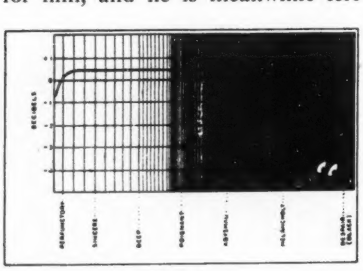


Fig. 1

free to engage in activities which may be regretted later. The device is guaranteed to bend every effort to perform its duties, being equipped with a dynamically stabilized microsynchronous effort bender of the cantilever type.

1.13 By means of a simple changeover switch, this device can be used to rue. Days are the least difficult of all items to rue. To "rue the day" it is necessary merely to set the machine up as described in section 19.3.

NOTE: See section 19.3.

1.14 The No. 2-B Regrettor may be adjusted to give down pangs of regret if such are desired. All frequencies up to 20 pangs per second are easily obtainable, it being necessary merely to use the output from jacks J-10 and J-11 as a ringing current on the drop side of all loops within reach, if desired.

2. Response

2.11 The response of the No. 2-B Regrettor is substantially uniform over the entire sad section of the emotional range, being less than 2db down at the perfunctory regret end, and 3000 db down at the black despair end. See Fig. 1.

a. Note: where a flatter characteristic is desired, the Regrettor may be flattered with a 22 type False Praise Lavisher.

1. *Caution: If an A.C. operated 22-C Lavisher is used, a filter will be required to smooth out the output.*

(a) The action of the Lavisher may be smoothed somewhat by applying a drop or two of non-gumming KS-7415 Guile in the duct provided for that purpose.

3. Output

3:11 To fill a crying need, the No. 2-B Regrettor has been designed to handle a maximum output power of 60 watts, R.M.S. (Room for More Surges). This is far in excess of the power required in ordinary household or industrial use.

NOTE: It is of interest to note the fact that the No. 2-B Regrettor will withstand excessive overloads for long periods. Preliminary tests have been made, in which the Republican Party assisted in tests to destruction of the No. 2-B Regrettor. While regretting for the Republicans, the test unit operated under conditions of almost 143.5% overload continuously for 10.5 years without failure, and this failure was directly traceable to an abnormally high concentration of hot air and cigar smoke which seriously interfered with proper ventilation.

4. Mechanical Arrangement

4.11 The No. 2-B Regrettor unit is relatively light in weight, moderately small in size, fairly mobile, and essentially the type of apparatus known as portable. A typical installation is pictured in Figure 2.

4.12 Overall dimensions are approximately as follows:

(a) Width: 24 33/64 inches
(b) Length: 60 63/64 inches
(c) Height: 40 37/64 inches

Note: These dimensions are overall and include the carrying handles.

Caution: The handles are not furnished with the unit and must be ordered separately.

(1) Bronze only is furnished when specified.

Note: Nickel screws only are furnished with handles.

(2) Screws should match the handles.

Note: Screws should be ordered separately.

4.13 The total weight of the in-

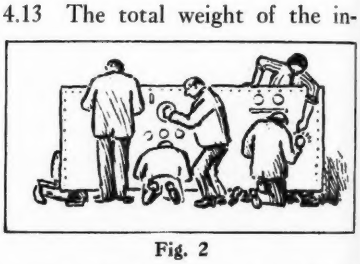


Fig. 2

strument including the No. 221-C Mounting is approximately 1,242 pounds, 8 ounces, 10 grams, 1 grain.

4.14 Controls are brought out to the front panel for accessibility. For ready maintenance on the interior of the cabinet, the 25 knobs and 15 keys are removed and the front panel is then removed by unscrewing 112 machine screws and running an oxyhydrogen torch along the edges of the panel.

5. Installation and Operation

5.11 The Regrettor should be placed in as bright and cheery a location as possible. Dark, dank corners should be avoided inasmuch as the instrument generally surrounds itself with an atmosphere of gloom and where this cannot be dissipated rapidly, it builds up to an undesirable concentration in the vicinity.

5.12 The maximum attitude

(*Continued on page* 30)

NEW PUBLICATIONS

Electrical Engineering, Basic Analysis. By Everett M. Strong, Professor of Electrical Engineering, Cornell University. *New York, 1943, John Wiley and Sons, Inc. 391 pages, with many illustrations. $4.00.*

The title of this book is not correctly understood by those who would class it with the usual "Fundamentals of Electrical Engineering", for though it is a "first course" textbook, it is entirely new in presentation and construction. It is really what its subtitle says, a "Basic Analysis," an analytical introduction into electrical engineering — applied electricity and magnetism—with the emphasis on a sound approach to basic phenomena.

Ever since Professor Strong was placed in charge of the first course in electrical engineering, given to the Cornell electrical engineering students in their fourth term, he felt the need for an appropriate text. This book is the result of mimeographed notes which were written after careful planning and with much thought, and tried out for many years in a number of classes. Each year, these notes were revised and improved on the basis of the results in class and the students' reactions to the presentation. Many of the problems are original and very helpful in developing logical study habits. Those who knew the earlier editions of the mimeographed notes—about half a generation of Cornell electrical engineering graduates—will find that the general layout of the book remained unchanged, but nearly everywhere details are added, or the formulation is slightly changed to make the text still clearer.

As a basic analysis it is to be expected that electric and magnetic circuits would be treated, and also both d.c. and a.c. circuits, together with network theorems and elementary transients. This very brief description of some of the high spots shows that this book is indeed a complete course of basic concepts, and whoever uses the text should be able to solve many problems encountered in practical electrical engineering.

When the first edition of the mimeographed notes was written no one thought of the specialized military training programs and of the students in uniform who now fill our class rooms. It is of interest to note that Strong's text is recommended for the course AST 405 in the Army Specialized Training Program and the course EE 3 in the Navy College Training Program.

Prof. E. M. Strong

Because of its many new features, because this book is unusual in many ways, it has a usefulness that should prove of advantage to engineers, instructors, and students alike.

By E. T. B. Gross

Faculty Papers

Three publications by members of the Cornell University faculty have made their appearance recently. "Radiant Heating and Cooling" by C. O. Mackey, L. T. Wright, Jr., R. E. Clark, and N. R. Gay (40c), together with "The Solution of Simultaneous Linear Equations by an Approximation Method" by L. T. Wright, Jr., (15¢) are publications of the Cornell University Engineering Experiment Station. "Dielectric Properties of Animal Fibers" by Jacques Erra and Henri S. Sack, Cornell University, appeared in *Industrial and Engineering Chemistry,* Volume 35, June, 1943.

"Radiant Heating and Cooling" is the first of a series of bulletins representing the results of investigations conducted on the economy and comfort of radiant heating and cooling. The bulletin includes data relating to radiant heat exchanges within a room. Charts and tables of angle factors for various surfaces are also contained in the report. It is the purpose of later study to investigate engineering factors in a model room and eventually to present physiological and psychological data, as well as engineering data, obtained from a study of human subjects in a test room to be built in the constant temperature laboratory of the Sibley School of Mechanical Engineering.

The second bulletin issued by the Experimental Station presents a simple time-saving mechanical process for finding a solution of simultaneous linear equations to any desired accuracy. The third paper is an advanced study of the various dielectric properties of animal fibers, concerning itself with the electrical measurements undertaken in the study as well as the accuracy of the method employed. The author also discusses the preparation of the fibers, the properties of wool, silk, and nylon, and the structure of stretched and unstretched fibers.

The following other publications, appearing within the last two years, may also be obtained by writing to the Engineering Experiment Station, Cornell University, Ithaca, N. Y.

"Flexural-Torsional Buckling of Bars of Open Section Under Bending, Eccentric Thrust, or Torsional Loads" by J. N. Goodier (30¢).

"Some Factors Influencing the Heat Output of Radiators" by David Dropkin (25¢).

"The Specific Heats of Certain Gases over Wide Ranges of Pressures and Temperatures" by Frank O. Ellenwood, Nicholas Kulik, and Norman R. Gay (50¢).

FRESHMEN

Dr. Gross

E. T. B. Gross

LANCASTER County, Pennsylvania, is the best in this country," says Dr. Eric T. B. Gross, advisor to the E.E. Frosh who entered in July. His Cornellian wife, Catharine, comes from there.

Dr. Gross was born in Vienna, Austria, in 1901. He was educated at the University and the Institute of Technology in Vienna and received the E.E. degree, with highest honors, in 1923 and the D. Sc., Summa Cum Laude, in 1932. As an undergraduate, he held the Gustav A. Peschka and the J. G. Geiger Scholarships in succession. Soon after his graduation, he became associated with the A. E. G. Union Electric and Manufacturing Company of Vienna, a company associated with the General Electric Co. in this country, and by 1935 he had become the head of the Central Station Department's Engineering Division. After working in England during 1938 as a Consulting Transmission Engineer, Dr. Gross came to America and Cornell where he became first a Resident Doctor, then a Research Associate, and later Professor of Electrical Engineering.

Dr. Gross is noted for his work on high tension transmission problems. In 1937 he was chairman of the section on "High Tension System Protection and Ground Fault Problems" at the International Conference on Large High Tension Systems in Paris. He has written many papers and received patents on numerous protective devices for high tension lines within this country and abroad. Sigma Xi has recently elected Dr. Gross as one of its members in recognition of his work. He is also an honorary member of several social clubs both at Cornell and at C. C. N. Y. where he taught for a few years. This year, as counselor of the AIEE Cornell Student Branch, he is doing a great deal toward the expanding of that group.

As advisor to the Freshman class of E.E. students this year, Dr. Gross has found time to be interested in the individual. It is this interest in people and his interest in his work which have made him a popular person. He believes that the undertaking of a job should not be attempted unless it will be carried out completely and efficiently, and he acts on that belief.

When he left Europe, Dr. Gross left behind the mountains in which he loved to ski. He finds little time to ski now, and few nearby mountains are high enough to afford real skiing pleasure. He is also a swimming enthusiast and enjoys motoring when has has the gas and a destination in mind.

Although he has never been as far as the West Coast, Dr. Gross has seen a large part of the United States. He believes that he has never seen anything which could compare with Yellowstone Park and he says that the Rockies remind him of the Alps. His feeling toward America is summed up by his statement that he cannot see why any person who has come here after having lived in Europe would want to return there.

H. M. Gifft

THE C.E. advisor for entering freshmen is Professor Howard Merrill Gifft. For the benefit of these freshmen we reprint the following article which appeared on the "Prominent Engineers" page of the April, 1943, issue of the ENGINEER.

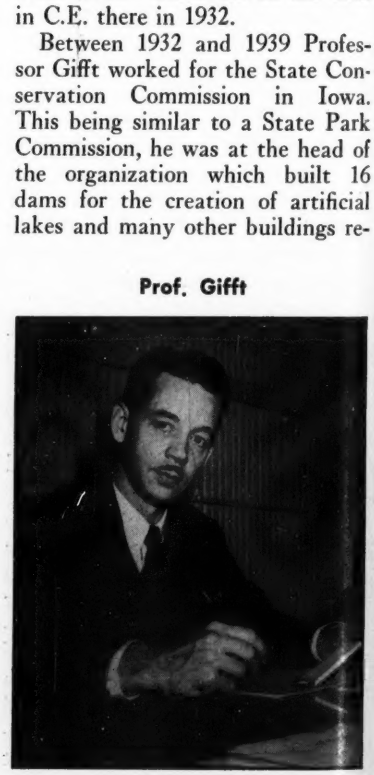
Civil Engineers are now quite familiar with the face of Assistant Professor Howard Merrill Gifft. Though coming here only two years ago, he has made a place for himself and is now conducting courses in Structures and Sanitary Engineering.

Professor Gifft, hailing from Boone, Iowa, went to Iowa State's School of Architecture after leaving high school in his home town. That he really got around in college is seen in the fact that he was President of his class in his Sophomore year, and also a member of the Student Council. He joined the Kappa Sigma fraternity at this time also. At the end of his Sophomore year he left school for five year's work with the Iowa State Highway Commission. On this he was a Survey Party Chief for two years, and in Road and Bridge Design for three.

When he returned to college, he entered the School of Civil Engineering. However he still enjoyed art work very much, and became Art Editor of his campus humor magazine, and as a sideline, head cheerleader for Iowa State. During this time he married an Iowa State coed. He received his B.S. in C.E. there in 1932.

Between 1932 and 1939 Professor Gifft worked for the State Conservation Commission in Iowa. This being similar to a State Park Commission, he was at the head of the organization which built 16 dams for the creation of artificial lakes and many other buildings re-

Prof. Gifft



ADVISORS

lated to the erection of new park facilities during the time he was an engineer with them. In this work he received much valuable experience and thus is well qualified for his work at Cornell.

After he finished work with the Conservation Commission, he went back to Iowa State as an Instructor in Civil Engineering, and stayed until 1941 when he received his M.S. in C.E. and his degree of Civil Engineer there. Then he came to Cornell where he was appointed Assistant Professor in Civil Engineering, the position which he holds now. He is a member of the A.S.C.E. and the S.P.E.E.

Professor Gifft, though a Westerner by nature, enjoys his work here at Cornell and has become a good friend to all C.E.'s with whom he has come in contact. Apparently he is one of the few and far between who really enjoy Ithaca weather, for he says that compared to the heat in the summertime and the cold in the wintertime in Iowa, Ithaca's climate is wonderful.

J. W. Fitzgerald

THE freshmen in Administrative Engineering in Mechanical Engineering have as their advisor Mr. J. W. Fitzgerald.

Entering Cornell as a freshman in the fall of 1922, Mr. Fitzgerald pursued the six year course leading to degrees of both A.B. and M.E.

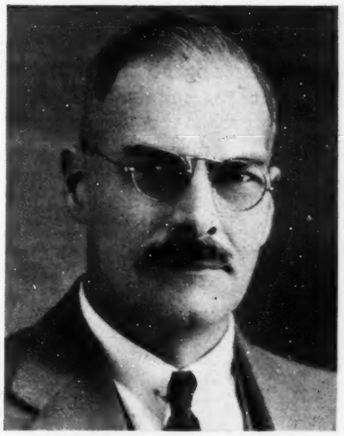
Mr. Fitzgerald

His undergraduate days were well filled with athletics and other activities as well as study. Mr. Fitzgerald played freshman football, was on the crew, pitched for the baseball team, and won his major "C" by throwing the javelin for the track team. A member of Zeta Psi fraternity, he was elected to the honorary associations Sigma Xi, Phi Kappa Phi, and Atmos, the latter one of which he was president. After receiving his A.B. degree in 1926, Mr. Fitzgerald continued his studies in engineering and at the same time served as an instructor in the Mechanical Laboratory. Receiving his ME degree in 1928, he continued instructing in the Mech Lab and carried on graduate work which led to an M.M.E. in June of 1929.

With the completion of eight full years at Cornell, the present freshman advisor departed for Europe with a John McMullen scholarship for study abroad. The main part of his work was with the Central Electricity Board of Great Britain. This was described by him as a national integration of the entire electric power supply of Great Britain. While carrying on this work, Mr. Fitzgerald studied at the London School of Economics. Before he left England, he became a Fellow of the Royal Economic Society.

Before the outbreak of hostilities in Europe, he travelled quite extensively on the continent and became quite familiar with conditions in France and Germany. He was located in London during the first years of the war while the city underwent the terrific bombing seige. This experience has left him many interesting memories and a sensitive appreciation of the peacefulness of Ithaca.

In August of 1942, he returned to America and is at present an instructor in the Department of Administrative Engineering. Mr. Fitzgerald's long stay at Cornell as both an undergraduate and a graduate student as well as his wide experience abroad, makes him well qualified indeed for his newest task as freshman class advisor.



Prof. Northrop

B. K. Northrop

PROFESSOR B. K. Northrop, advisor to the entering EE freshmen, is well suited to his task, having been a student here during the last war. He easily remembers the shrinking of his classes as more and more of his fellow students left for the services.

Professor Northrop attended Stetson University for two years after preparing at a boys school in Florida. As a sophomore he transferred to Cornell. The following year his career as an instructor began when he taught freshman physics. In his senior year, Professor Northrop was an instructor in Materials, and following his graduation in December, 1918, he remained on with the engineering staff.

"The big black cigar" always associated with Professor Northrop is indicative of the congenial relationship which exists between himself and his students. One day, several years ago, he appeared in class smoking a cigar as is his custom. During the recitation he laid the cigar on the desk and forgot about it. The next day, all of the students who were capable of so doing entered the classroom smoking cigars. On the day of the final exam a cigar about one foot long and an inch in diameter was placed on the Professor's desk. Professor Northrop accepted the challenge and while the boys pondered over the exam he puffed contentedly on the cigar.

Although his hobby is work, Pro-

(*Continued on page 22*)

Machine Tool Builder

(*Continued from page 6*)

their engineering ability and their equipment are suitable. This involves a problem which is easily overlooked, and that is the problem of a company entering a field which is new and which requires different selling methods, different sales outlets, and perhaps an entirely different advertising technique. The machine tool builder will find himself in competition with companies that have long occupied those fields and which have long developed their sales outlets and their public acceptance.

Furthermore, this is not an ideal solution from the point of view of the national interest, for the machine tool is the least common denominator of prosperity in time of peace, and safety in time of war, and the United States should always have a vigorous machine tool industry. It is the resourcefulness of the machine tool builder in improving his product that has made possible the production of better automobiles at lower prices. Before the maker of airplane engines can step up the horsepower of his engine he turns to the machine tool builder for better machine tools, machine tools that can produce to tolerances of one or two ten-thousandths of an inch. It is on this foundation that we have built the output of tanks, guns, and planes needed during the war. It would have been impossible to win air superiority over Italy, to defeat the submarine in the Atlantic, and to assume the offensive in the Pacific area if we had not had a vigorous machine tool industry in 1939.

Scrap Old Machinery

The remedy is to absorb existing machines of recent manufacture, at home and abroad, by scrapping older and less productive machines. In addition, to give the industry an opportunity for re-designing and improving their product by allowing them to retain as reserves such earnings as remain after they pay excess profits taxes. The Renegotiation Act should be amended so that proper consideration is given to the nature of a contractor's business and to his future outlook. Even under those conditions the companies like the machine tool builders, who have swamped their future market for many years, face a very difficult problem of survival.

It is not a question of rewarding the service rendered during the war. It is purely a matter of giving industries that are essential to the future well-being of the nation a fighting chance to survive.

In the last resolution, American industry can pay out larger sums in wages than the Nation can possibly afford to pay out for relief. Before industry makes expenditures, the money must first be earned. What the Government spends must be recovered in the form of taxes. The key to the solution of our post-war economic problem is the production of more things for more people at lower cost. This is the road that leads to sustained employment at good wages, and is a far better procedure than subsidies or boondoggling. It is not a short cut to the millennium, but it does lead in the right direction.

Difficult as the outlook is, the machine tool builder must play his part in the war that will follow the present war, the war to place on a permanent and substantial foundation a higher standard of living for the American people.

WHAT'S SPIRAL-4?

Closely following our advancing forces rolls a truck, with Signal Corps men paying out telephone cable. There are no stops for splicing—for the ends of the quarter-mile lengths are fitted with weather-proof connectors that snap together.

This is Spiral-4—a new type of rubber-covered field cable which helps the Signal Corps establish communications *quickly*. When connected to suitable terminal carrier equipment, this Western Electric product provides three telephone and four telegraph circuits in a single cable—about the thickness of a fat pencil—containing four spiralling wires.

Another important feature of Spiral-4 is that an enemy tapping this cable—when *carrier channels only* are being utilized—would get nothing but a jumble of sounds.

This new carrier type communications system is but one of many war products on which Western Electric engineers are working now—developing special manufacturing equipment and methods. This field of Engineering for manufacture offers a wide range of opportunity to men who are interested in the technical problems of production.

BUY WAR BONDS REGULARLY—ALL YOU CAN!

Western Electric

IN PEACE...SOURCE OF SUPPLY FOR THE BELL SYSTEM.
IN WAR...ARSENAL OF COMMUNICATIONS EQUIPMENT.

ARMY E NAVY

B. K. Northrop

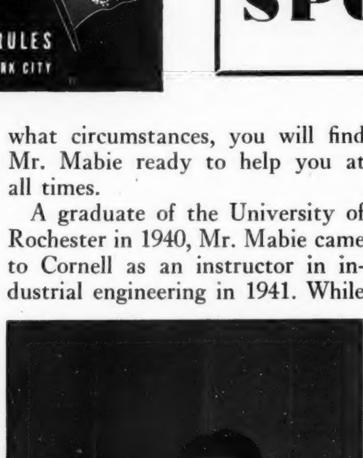
(*Continued from page* 19)

fessor Northrop's interest in his students is sincere and he derives much pleasure from aiding them. Informality is the tone of his recitations, good humor the keynote of his laboratory. His analogies for electrical phenomena are original and enlightening. His lectures are made interesting by his quick wit and ready smile. Strong in teaching experience and well founded in the techniques of dealing with student problems, Professor Northrop should prove most helpful to those entering upon the study of Electrical Engineering.

Hamilton H. Mabie

No doubt many of you mechanical engineers have already met Mr. Hamilton H. Mabie either during registration and assignment of advisors at Barton Hall or in the classrooms in Sibley. Perhaps you will be seeing more of him during the private conferences on scholastic records, satisfactory or otherwise. But no matter under what circumstances, you will find Mr. Mabie ready to help you at all times.

A graduate of the University of Rochester in 1940, Mr. Mabie came to Cornell as an instructor in industrial engineering in 1941. While



Mr. Mabie

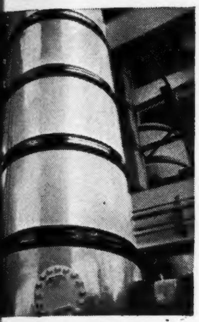
in college, he worked during the summer in various phases of enginеering from purchasing, cost calculating, and drafting to mechanical and industrial supervision.

In his free time, when he hasn't been thinking up new problems for his classes in plant layout and in motion and time study, Mr. Mabie has done a great deal of research on internal combustion engines, for his avocational interests are industrial engineering and internal combustion engines. During the past year he has also been teaching some government-sponsored courses for the E.S.M.W.T. program and is now teaching production engineering to the Curtiss-Wright cadettes.

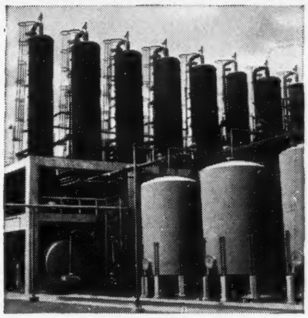
To freshmen and returning students who haven't been here this summer, Mr. Mabie wants especially to say that he would like to have you come to him with any of your problems or difficulties. This summer the work of students in industrial engineering, Mr. Mabie found, was of much higher caliber than that of many of the previous terms. Perhaps it is due to the fact that many students have a different purpose to urge them to study. At any rate this spirit certainly was a welcome one, and it is hoped that the contagion will spread into this term.

TEN YEARS' WORK IN TWO

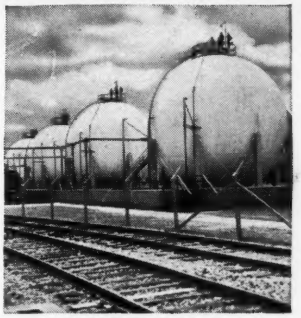
is the story behind Butadiene and Styrene for Synthetic Rubber



Distillation Column for Styrene



Where Distillation Columns separate and purify the Butadiene



Butadiene Storage Spheres

WE WISH YOU could see the first of the Government's large integrated synthetic rubber projects, complete at one location. What you see here is a night scene and some daytime views of the immense butadiene and styrene plants that CARBIDE AND CARBON CHEMICALS CORPORATION, a Unit of UCC, has designed and built at Institute, West Virginia, for the Government's Defense Plant Corporation and is operating for the Rubber Reserve Company.

Carbide and Carbon also has completed another butadiene plant at Louisville, Kentucky —and has released plans to Koppers United Company for a third butadiene plant near Pittsburgh, Pennsylvania.

Butadiene had never been manufactured in the United States in large quantities before the plants at Institute went into production. The task involved in providing the mass production facilities the Government asked for was an unusual one...but one that took full advantage of the experience and processes developed by Carbide and Carbon.

Generally, it requires seven to ten years for a company to take a process developed in the laboratory, put that process to test in a pilot plant, iron out production problems, design a full-size plant, and then actually build the plant and go into mass production.

By working at top speed for twenty months —Carbide and Carbon telescoped research, development, engineering, and construction work that would have taken 10 years in normal times. In this short time laboratory research was translated through chemical engineering into larger and more modern facilities for producing the chemicals for synthetic rubber than existed anywhere else in the world.

This achievement could never have been possible had it not been for the years of research and experimentation which, prior to the emergency, Carbide and Carbon had devoted to the production of synthetic—or man-made—chemicals of the organic series.

Business men, technicians, teachers, and others are invited to send for the book "Butadiene and Styrene for Buna S Synthetic Rubber from Grain Alcohol" which explains what these plants do, and what their place is in the Government's rubber program.

• • •

BUTADIENE, (bew-ta-dý-een). A highly volatile liquid which is the principal chemical in the manufacture of Buna synthetic rubbers.

STYRENE, (stý-reen). A liquid, like benzene, but having the property of reacting within itself to form a solid, clear, plastic mass. It is used as one of the principal ingredients of Buna S synthetic rubber.

BUY UNITED STATES WAR BONDS AND STAMPS

UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street UCC New York 17, N. Y.

Principal Products and Units in the United States

ALLOYS AND METALS
Electro Metallurgical Company
Haynes Stellite Company
United States Vanadium Corporation

CHEMICALS
Carbide and Carbon Chemicals Corporation

ELECTRODES, CARBONS & BATTERIES
National Carbon Company, Inc.

INDUSTRIAL GASES AND CARBIDE
The Linde Air Products Company
The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

PLASTICS: Bakelite Corporation • Plastics Division of Carbide and Carbon Chemicals Corporation

CONSTRUCTION RECORD AT INSTITUTE

June 25, 1941
Carbide and Carbon submits definite production estimates.

July 31, 1941
Design work starts on 10,000-ton-a-year butadiene unit.

Aug. 22, 1941
Government authorizes construction.

Dec. 7, 1941
Pearl Harbor

Dec. 15, 1941
Design "frozen" for 20,000-ton-a-year alcohol-to-butadiene plant.

March, 1942
Japanese occupy Malay Peninsula and Dutch East Indies; cut off about 90 per cent of U.S. natural rubber supply.

April, 1942
Construction on the first of four 20,000-ton-a-year butadiene units starts at Institute, W. Va.

July, 1942
Construction of 25,000-ton-a-year styrene plant starts.

Sept. 10, 1942
Rubber Survey (Baruch) Committee report accepted.

Jan. 29, 1943
First large-scale, alcohol-to-butadiene unit goes into operation two months ahead of schedule.

April 7, 1943
First styrene unit begins operation.

May 25, 1943
Fourth 20,000-ton-a-year butadiene unit begins operation at Institute plant.

August, 1943
Four 20,000-ton-a-year butadiene units producing at rate of 120,000 tons a year—50% over rated capacity.

Army-Navy "E"

(*Continued from page* 14)

president of the company, while John C. Wilson, Jr., M.E. '35, is assistant to the president in charge of production.

Herman Pneumatic Machine Co. of Zelienople, Pa., won its Army-Navy "E" on October 1. Thomas Kaveny, M.E. '94, has been president of the company since 1914. His sons, Thomas Kaveny, M.E. '26, and Robert Kaveny, M.E. '29, are also associated with the firm.

S. Blickman, Inc., of Weehawken, N. J., manufacturers of galley and hospital equipment for ships and stainless steel alloy equipment for the chemical explosives industries, won its Army-Navy "E" on October 22. Saul Blickman, C.E. '11, is president of the company and his sons, Bernard I. Blickman '36 and Newton A. Blickman '38, are working with him.

Lewis B. Smith, M.E. '12, is president of the Taylor Instrument Companies in Rochester, manufacturing temperature, pressure, and flow instruments, which received the "E" award on July 29.

The Cleveland Worm and Gear Co. and the Farval Corp. of Cleveland, Ohio, of which Howard Dingle, M.E. '05, is president, also fly the Army-Navy "E".

The Fred S. Gichner Iron Works of Washington, D. C., has added the star for six months' sustained production to the "E" award won last March. Henry Gichner, M.E. '29, is vice-president of the company.

George Tallman Ladd

GEORGE Tallman Ladd, M.E. '95, died in Pittsburgh, Pa., near his home in Coraopolis Heights on October 3, 1943. He was internationally known as an industrialist and was president and director of the Engineering and Foundry Company of Pittsburgh from 1928 until his death. In addition, he served as president of several other prominent companies in that area. Last year, he was awarded the honorary degree of Doctor of Engineering by Bucknell University, of which he was a trustee. The Mechanical Engineering Department at Bucknell, in fact, is named in his honor. He undertook important work in the application of high-pressure steam generator units to the requirements of modern power plants, having designed the water-tube boilers for Ford, the largest boilers of this type in the world.

His son, Tallman Ladd, is a member of the class of '21.

South of Salerno

ONE of many Cornellians distinguishing themselves in the war in Italy is Major Edmund A. Cobb, M.E. '29, who was recently awarded recognition in an AP dispatch from "Somewhere South of Salerno." According to the AP correspondent, the American Air Force Service Unit which he commanded went into action with regular combat troops at a critical point of the battle for the beachheads. An English major directing an engineering unit asked Major Cobb for help in stemming a German counter-attack which threatened to break through his right flank. Although the American air field workers had had no previous combat experience, they teamed together with the British engineers and with no small hardship quickly erected a series of barbed wire entanglements and field fortifications, manning the

(*Continued on page* 26)


TECO CONNECTORS
and the services
that go with them
TECO Design Service
Teco has available for distribution to architects and engineers complete data on all phases of timber design, including tables and charts on timber beams, columns, floors, connector loads, bolt loads, stresses, etc.
TECO Consulting Service
Teco maintains a staff of engineers to consult with architects and engineers on their design problems. Teco Connector distributors and fabricators in all parts of the country also render helpful services to architects and engineers.
TECO Typical Design Service
"Typical Designs of Timber Structures"—a 100 page book—is available to architects and engineers free upon request. Copies of several hundred other designs of typical Teco Timber Structures are also available on request.
TECO Research Service
Teco conducts a continuous research program as well as sponsoring research at outstanding engineering colleges and laboratories to increase the design knowledge of timber designers. The benefits and results of this research are passed on to interested individuals in the form of design data and improved products.
Specifications: Specify Teco Connectors and grooving tools by name. They are endorsed by leading lumber manufacturers and fabricators.
TIMBER ENGINEERING CO.
National Manufacturers of TECO Timber Connectors and Tools
WASHINGTON CHICAGO PORTLAND MINNEAPOLIS
Specify Them!

South of Salerno

(Continued from page 24)

machine guns themselves. Thanks to the cool-headedness of Major Cobb and the valiant action of his men, the German infantry was prevented from breaking through the Allied positions.

Major Cobb, who graduated from the Mechanical Engineering School in 1929, was a lineman on Coach Dobie's football team during his undergraduate days. He played professional baseball and football after graduation, and later was employed by the Sun Oil Company in Texas.

AIEE Prize Winner

R. C. Van Sickle, E. E. '23, circuit breaker and protective devices engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has received honorable mention in the American Institute of Electrical Engineers' 1942 national prize award for the best paper in theory and research for his paper, "Transient Recovery Voltages and Circuit-Breaker Performance."

Mr. Van Sickle has been associated with the Westinghouse Company since 1924. After two years in the student course and the supply engineering department, he became circuit-breaker engineer. From 1928 to 1930 he was exchange and liaison engineer for the Westinghouse Company at the Siemens Schuckert Works, Berlin, Germany.

John Maiston Joy

John Maiston Joy, M.E. '12, died in Yonkers on October 12, 1943. A member of Alpha Tau Omega, he studied at M.I.T. after leaving Cornell. In 1935, he became associated with William Fox, theater owner and film producer. A pioneer in the development of motion picture sound effects and talking pictures, he worked in the industry as a technical adviser until his retirement several years ago.

American Ingenuity

(Continued from page 9)

clubs.

But these are mere technical questions, which will be easy enough to solve. What we need now is the realization that wars are coming more and more to be won by inventions, and that the security of the nation depends to a large extent on how well it cares for its inventors. In the past we have condemned them to develop their ideas without equipment, and when successful, have allowed them to be cheated by iniquitous patent laws. Now is the time to make the plans that will prevent this happening again. Little actual work, other than planning, can be done now, as all the apparatus we can produce is needed elsewhere; but after the war, when the competition for international markets sets in, we should be wise to utilize every available resource of our nation. A great and hitherto unexploited field is the amateur inventor, the man with the bright ideas but no facilities for working them out. If provided with adequate equipment, he can more than pull his weight in the post-war world.

D.F.C. Awarded

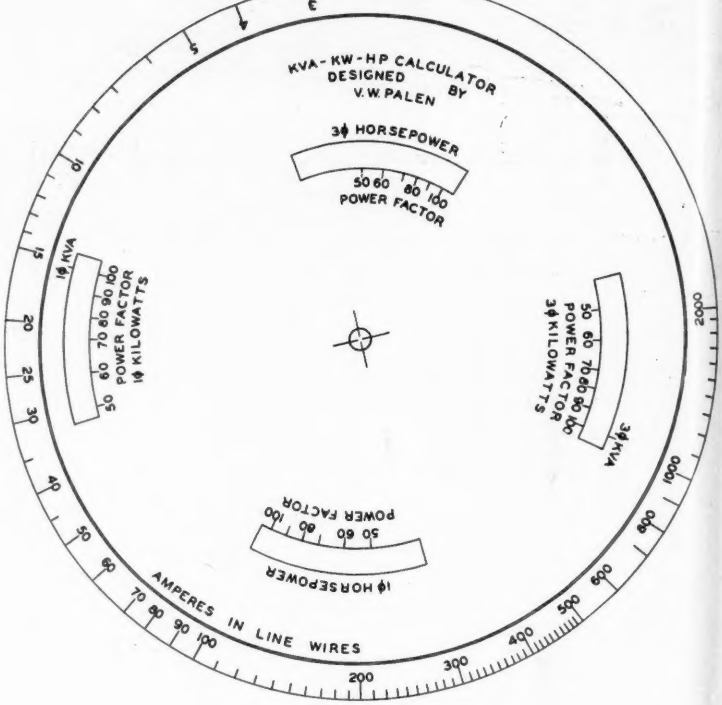
Lt. John M. Hart '36, a graduate of the C. E. School, has received the Distinguished Flying Cross for outstanding performances with the Army Air Corps in the South Pacific.

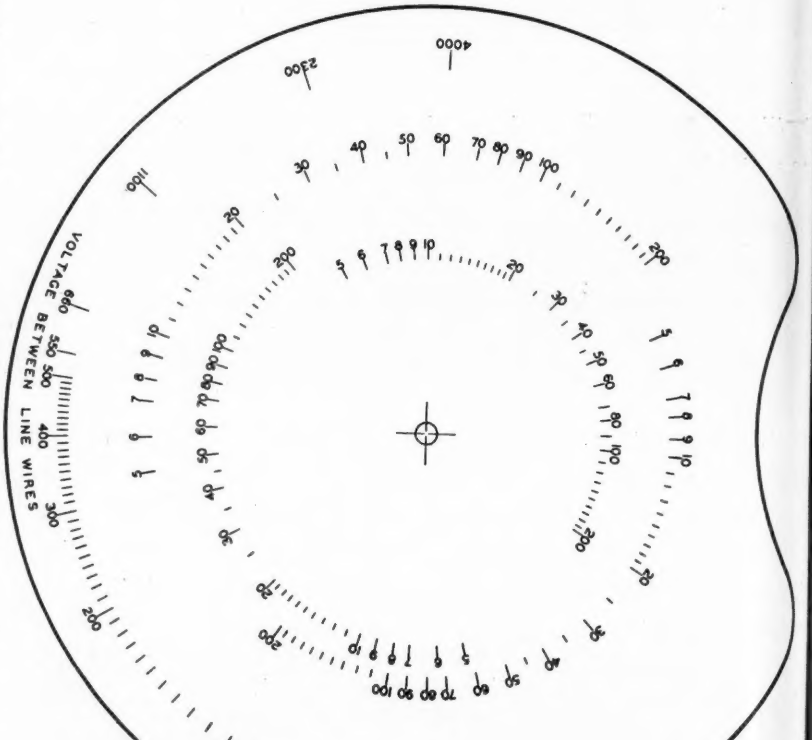
E.E. CALCULATOR

ENGINEERS will find the Kva-Kw-Hp Calculator shown at the right a very useful gadget to have on hand. It saves much time in making routine calculations involving electrical quantities. Developed by V. W. Palen of the Westinghouse Company, it can be used to find Kva, Kw or Hp from known values of amps and volts or amps for given values of voltage, Kva, Kw, or Hp. Thus, knowing the size motor to be installed, one can quickly determine amps; from this one knows what size wire to use for the circuit. Conversely, when amps at transformer terminals are read, the calculator tells what load, in Kva, the transformer is carrying.

To assemble, cut out both discs (also small windows) and mount on cardboard with rubber cement. Punch the center holes carefully; then insert a small bolt in the holes. Washers, if used, will save wear and tear on the paper. The bolt should be tightened to give the proper pressure on the disc; they must hold their setting, yet turn easily. A drop of solder applied to the nut will make the assembly permanent.

The range of the calculator, 5 to 200 (Kva, Kw, or Hp, as the case may be), can be extended easily to cover a range of 50 to 2000 merely by multiplying all values by 10.



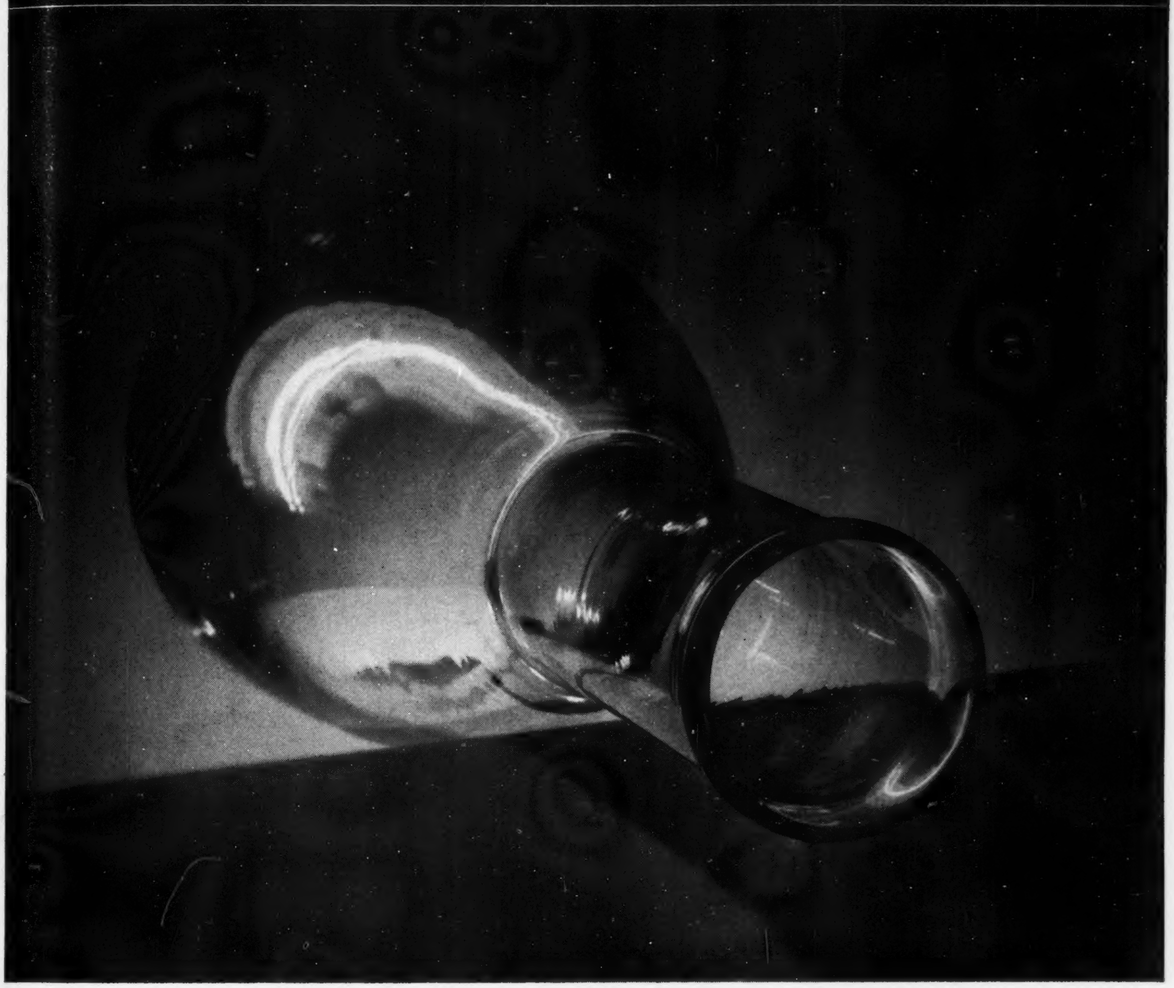


Board of Trustees Appoints

THE Board of Trustees of Cornell University has announced two major appointments to the executive staff, those of Dr. George H. Sabine as Vice-president of the University and Sherman Peer, Ithaca attorney, as Provost pro tem. The position of Provost has been vacant since April.

Mr. Peer will have charge of developing the University's financial resources for the support of the endowed colleges. He will work with the trustee committee on planning and development at Cornell. This committee is now working on a program for the post-war period which will include a new Graduate School of Aeronautical Engineering and further development of the present College of Engineering.

Submarine hunt in the Chemung Valley...



NO, it isn't a gun or a new style bomb. It's all we can show you of a special glass tube that is part of our secret submarine listening apparatus.

The same kind of tubes are used in listening devices that can pick up the menacing hum of an enemy plane miles away. And they're made out of special glass, to exacting requirements, by skilled Corning workmen in the peaceful Chemung Valley in Southern New York State.

Did we say "peaceful"? That isn't exactly correct. No subs actually prowl the Chemung, but there's plenty of warlike activity going on at Corning Glass Works, just as in every glassworks in the whole United States.

For Corning, like other glassmakers, was ready to turn its skill and experience to our country's use before the smoke had cleared at Pearl Harbor. For example, since World War I, Corning has developed medical and chemical glassware that frees this nation from dependence on foreign imports. This material is now flowing in a steady stream to industry, hospitals, and laboratories.

Hundreds of other items are made by Corning to aid the war effort. Optical glass, insulators for planes and tanks and ships, heavy glass parts for the manufacture of explosives, even glass precision gauges (ring, plug and others). Many of these jobs represent new uses for glass, where glass replaces metals because it is strong, resistant to wear and corrosion, and fairly plentiful. After the war many of these uses will stay, and new ones will be added because glass is a material of endless possibilities. And then, as now, Corning will be the center of American glass research.

In your own future as an engineer, *keep your eye on glass!* Corning Glass Works, Corning, New York.

CORNING
means
Research in Glass

Loose Juice

(*Continued from page* 16)

should not be allowed to become higher than a medium "pall of gloom". Attitudes higher than this produce a corrosive degenerative effect on the instrument causing its output to drop off, and ultimately the machine will go into a decline and waste away in the manner of an exponential function.

5.13 The Regrettor should be mounted vertically.

(a) When mounted horizontally the grid leak resistors cannot drain rapidly enough and the result is as shown in Figure 3.

Note: See Figure 3.

(b) It is to be understood that this is representative of an average case only.

(c) Average cases are difficult to find.

Note: It is doubtful if such exists.

5.14 The assignment generally used to determine that the set is functioning properly is essentially that of regret at having purchased the instrument. The procedure below should be followed:

(a) Set the switch D2 to the "Regret" Position.

(b) Advance "Output" control to about half full scale.

(c) Rotate the "Quality" dial to the setting marked "Pangs."

(d) Look at invoice reading "Price: $3,145.25, slightly higher west of Boston."

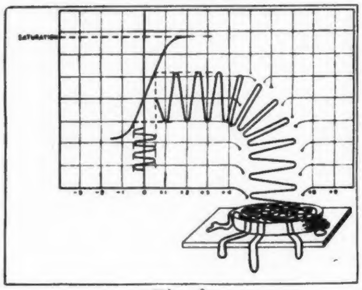


Fig. 3

(e) Observe that the Regrettor has a single high amplitude pang and note the immediate cessation of doubt and regret at having bought the instrument.

Note: (a) If it is found that following this pang, a wish to buy another identical unit arises, the "Output" control was set too high.

6. Calibration

6.11 The calibration of the No. 2-B Regrettor is most conveniently checked by the arbitrary values of regret felt on March fifteenth. The desirability of the type of regret connected with this date lies in the fact that it is a universal standard, welling up on every hand, and flavored with equal bitterness everywhere. The following procedure is recommended in calibrating the No. 2-B Regrettor.

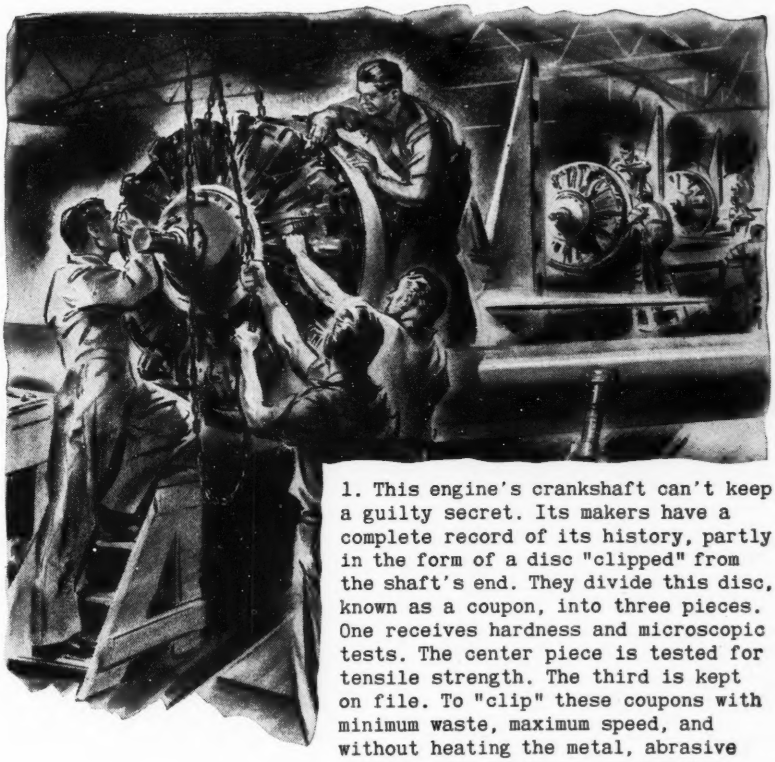
(a) Set the Regrettor "Quality" dial to "Aching" and leave D-1 turned "Off".

(b) Look at notice from Bureau of Internal Revenue and recall the 1940 Presidential Campaign.

(c) Observe dull ache near billfold.

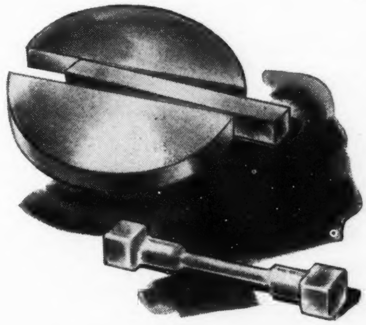
(d) Suddenly turn Regrettor switch D-1 to "On" and observe that as tubes heat and Regrettor takes up the load, ache near billfold subsides and a wish is felt to rise and sing first two verses of "We're With You, Mr. President."

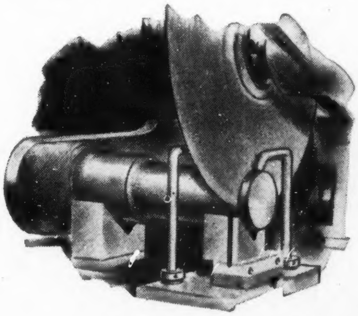
Clipping coupons from airplane engine crankshafts!



1. This engine's crankshaft can't keep a guilty secret. Its makers have a complete record of its history, partly in the form of a disc "clipped" from the shaft's end. They divide this disc, known as a coupon, into three pieces. One receives hardness and microscopic tests. The center piece is tested for tensile strength. The third is kept on file. To "clip" these coupons with minimum waste, maximum speed, and without heating the metal, abrasive cutting off wheels are employed.

2. With speed and precision counting for so much these days, abrasive cutting off wheels by Carborundum are coming into far wider use. In seconds they perform jobs which require minutes by ordinary methods. Such wheels are now used to cut plastics, glass, brick, tile, steel and non-ferrous metals in plate and bar stock faster and more accurately than they were ever cut before.





3. In industry you may run into abrasive applications that may be strange to you. When and if you do, remember that Carborundum is ready to help you solve your abrasive problems. The Carborundum Company, Niagara Falls, N. Y.

CARBORUNDUM
REG. U.S. BRAND PAT. OFF.
ABRASIVE PRODUCTS

Dr. W. A. Lewis

(*Continued from page* 13)

He began his engineering career in 1922 while employed in the Westinghouse service department in Los Angeles, California, when he successfully competed for one of the company's four-year War Memorial Scholarships. He was employed by the same firm during summer vacations as switchboard wireman, draftsman, and switchboard engineer.

Entering the central station department of the Westinghouse Company in East Pittsburgh in 1929, the present Cornell director became an authority on technical electrical problems, particularly those concerned with interconnection, stability, and high-voltage transmission. He invented high-speed relays for power system protection and assisted in designing substations and protective equipment for the electrification of the Reading Railroad.

He taught at the California Institute of Technology, developed courses in network solution by the method of symmetrical components, power station stability, and relay protection of power systems at the University of Pittsburgh, and originated an evening course for Duquesne Light Company engineers.

Dr. Lewis is the author of a book on symmetrical components and of several articles on electrical subjects. He has been the recipient of numerous professional honors.

A.I.E.E.

Frank V. Smith, of the Federal and Marine Divisions of the General Electric Company, spoke to the Ithaca section of the American Institute of Electrical Engineers October 8 on "Electric Ship Propulsion." On November 5, Dr. Walter W. Lewis, engineer in the Central Station Division of the General Electric Company, spoke to the same group and also the Student Branch. The topic which he discussed was "Lightning and Abnormal Dynamic Conditions on Transmission Lines." Over 125 people attended this meeting, after which doughnuts and cider were served under the auspices of the Student Branch.

The Student Branch recently decided to include a year's subscription to the Cornell Engineer with a new type of membership in the institute. About 200 students joined under this new membership plan. This type of membership was created in addition to the older type which included a subscription to *Electrical Engineering,* the national magazine of the institute.

Appointments

Approval of several appointments in the Engineering, Science, and Management War Training Program of Cornell University in Buffalo and Niagara Falls has been announced by President Edmund E. Day.

The following were appointed at Buffalo: William B. LaBorde as instructor in tool engineering and industrial coordinator in the Buffalo area; John F. McManus, instructor in structural engineering and resident administrator of the Buffalo ESMWT Office; Michelle A. Cook-Dallin, instructor in Chemical ingineering; Alexander N. Petroff, instructor in engineering; and John Rippstein, instructor in structural engineering and administrative assistant in the Buffalo area of the ESMWT program.

Approval was made of the following appointees as instructors in radio engineering at Niagara Falls until June 30, 1944: Vincent Aungier, George Banks, Harold Feder, James Hehir, Leonard Meyers, Robert J. Wilson, and Harold J. O'Connor.

Amplidyne

(*Continued from page* 12)

chines of the same capacity, however, because of the increased bulk of armature construction due to armature saturation and large copper losses. Thus, even from the standpoint of material costs alone, an Amplidyne is more expensive than the ordinary machine. It is the usual good economic practice to use the output of small Amplidynes to control large "conventional" motors, rather than to incorporate Amplidyne features into the motors themselves for direct control operation.

The qualities of the Amplidyne make it an ideal agent to use in the so-called "closed cycle" control systems, of which most of the instances of industrial application given above are examples. In closed cycle operation, a function of the performance characteristic of the controlled device—for example a voltage proportional to the speed of a motor—is impressed upon the controlling device and compared with a standard also expressed in the same function—in this case also a standard reference voltage. The controlling device acts on the difference between these two functions (voltages) to minimize any deviation of the performance characteristic from the ideal.

In addition to the proper expression of the controlled and reference characteristics into the same function, there are two other important factors for a closed cycle control system. One is that the voltage difference representing the deviation be amplified to a sufficient magnitude so that it may be used to produce the correction in the controlled process. The second factor is stability, for hunting or oscillations of the controlled process must be minimized. Instability is brought about by the existence of long time delays between correcting signals and the appearance of the desired effects in the process. When controlling large machines whose high electrical or mechanical inertias cause inherently long time delays, the overall lag can only be minimized by keeping the time delay in all other portions of the system, including especially the amplifier, at a very low value.

Is Simple and Rugged

The success of the Amplidyne as a controlling device and power amplifier in these systems is readily understood. The response time of the Amplidyne is extremely short; the amplification factor is so high that the most precise measuring devices may be used. In addition a linear response is obtained between input signals and output

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> *Congratulations to Mr. and Mrs. Martin Sampson on the birth on October 24, 1943, of a son, Martin III. Mr. Sampson is the Technical Faculty Advisor of the Editorial Board of the* Cornell Engineer.

Amplidyne
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power, a factor which adds to the stability of control systems. Last, and perhaps most important for its military applications, the Amplidyne is reliable, mechanically tough and able to take plenty of punishment, yet sufficiently elementary so that any mechanic, familiar with ordinary d.c. machinery, may perform routine tests and maintain it in operating condition without special training or additional equipment.

Multiple field control of the Amplidyne is responsible for many of its most spectacular uses. In one type of employment, for example, a small tachometer generator, whose voltage output is proportional to the speed of a large motor driving its shaft, is used to excite one control field of the Amplidyne. Another control field is excited by a fixed reference voltage, and it produces a flux which "bucks" that of the first field. As long as these two flux fields are in balance, the Amplidyne will supply field excitation for the motor to achieve a predetermined motor speed. If the motor speed tends to rise, however, the output of the tachometer generator will increase proportionately. This unbalance will produce a net increase in power output of the Amplidyne, and in motor field excitation, and the motor speed will decrease. The Amplidyne, therefore, will control the speed of the motor within very close limits, regardless of variations in load.

Other systems enable the Amplidyne generator, in similar fashion, to control torque, horsepower, current, voltage, power factor angle and many other related physical quantities.

Airplane Engine Speed Controlled

Amplidynes may also operate as motors as well as generators and as such one of their principle uses is adjustable constant-speed operation. A most important application of the Amplidyne in this type of operation was revealed in a recent article in *Aviation Magazine* on the new Curtiss Automatic Engine Speed Synchronizer for multi-motored aircraft. An Amplidyne, whose speed is controllable by the pilot, operates a series of three phase motors, each of which is synchronized with a three phase generator driven by one of the engines. A phase difference will apply correcting action to the pitch of the propellers so that all engines are operating at the same speed as the Amplidyne. Engine speed is thus automatically adjusted by merely changing the speed of the Amplidyne, an act which, as we have seen, is easily accomplished.

The Amplidyne is not the only power amplifier in wide use, as the popularity of controlled rectifiers, using electronic power tubes such as Thyratrons or Ignitrons, is also increasing. Since both have high amplification, coupled with great speed and long life, the choice between the two in a great many cases is simply a matter of preference for rotating machinery over electronic equipment or vice-versa. However, in instances where sturdiness of structure combined with simplicity of operation is a controlling factor, as in aircraft work, the Amplidyne is clearly the better choice. The future of industrial control holds plenty of room for both of these devices, however, and together they will introduce into mass production automatic, high speed and high quality processes on a scale which cannot be fully comprehended even today.

STRESS *and* STRAIN...

Statistics show that Princeton graduates have 1.3 children while Vassar graduates have 1.6 children. This proves beyond a doubt that women have more children than men.

* * *

"And please, Santa Claus," prayed the co-ed, "fill my stockings as well as God filled Betty Grable's.

* * *

He married Helen:
Hell ensued;
He left Helen:
Helen sued.

* * *

An infant was awakened from a peaceful slumber in a hospital. Looking down at his raiment, he yelled over to the occupant of the next crib, "Did you spill water on my diapers?"

"Naw" was the answer.

The infant looked puzzled for a moment and then said, "Hmmm, must have been an inside job."

* * *

"I'm losing my punch," said the coed as she hurriedly left the cock-tail party.

* * *

"How are you this evening, honey?"

"All right, but lonely."

"Good an' lonely?"

"No, just lonely."

"I'll be right over."

* * *

"You've been out with worse looking fellows than I am, haven't you?"

She did not reply.

"I said, you've been out with worse looking fellows than I am, haven't you?"

"I heard you the first time. I was trying to think."

* * *

"You look all broken up. What is the matter?"

"I wrote home for money for a study lamp."

"So what?"

"They sent me the lamp."

B.I.M. Professor: "Who was the cleverest inventor?"

A.E.M.E.: "Edison. He invented the phonograph and the radio so people would stay up all night to use his electric light bulbs."

* * *

A lady bought a parrot from a pet store, only to learn that it cursed every time it said anything. She put up with it as long as she could, but finally one day she lost her patience.

"If I ever hear you curse again," she declared, "I'll wring your neck."

A few minutes later she remarked rather casually that it was a fine day. Whereupon the parrot promptly said, "It's a hell of a fine day today."

The lady immediately grabbed the parrot by the head and spun him around in the air until he was almost dead.

"Now then," she said, "It's a fine day today, isn't it?"

"Fine day," sputtered the parrot, "Where in hell were you when the cyclone struck?"

* * *

Engineers are often baffled by the fact that some girls with streamlined figures offer the most resistance.

* * *

It happened in New York's largest department store during a rush. The elevator was jammed and the cables groaned.

The elevator rose slowly, and as it neared the third floor, a piercing scream caused the operator to stop midway. All eyes were focused on a large woman in a short seal coat who wore an injured expression. A small boy, not yet of school age, stood directly behind her.

"I did it" he announced defiantly, "It was in my face, so I bit it."

* * *

Drunk (to naval officer)—"Shay, call me a cab, will ya?"

Officer—"My good man, I am not a doorman. I am a naval officer."

Drunk—"Awright, then call me a boat. I gotta get home."

Darkness was settling down over the picturesque Scottish highlands, and the three American college girls who were enjoying the view from the top of the creaking stage coach began to shiver in the evening breeze.

"I say!" called the driver to the passenger below. "Is there a Mackintosh down there big enough to keep three young ladies warm?"

"No," came an eager voice from inside, "but there's a MacPherson doon here that's willin' to try!"

* * *

"Here's one Luther Burbank didn't try," said the coed as she crossed her legs.

* * *

A Cornell Engineer boarded the train at Buffalo, and, deciding to grab a couple of winks, liberally tipped the six-foot porter to put him off at Ithaca.

"I'm a very sound sleeper," he said, "and you must take no notice of my protests. Seize me and put me out on the platform."

The next morning he awoke to find the train pulling into New York City. Raging with fury, he found the porter and began to bawl him out in strong language.

"Suh," said the porter calmly, "you've got a whale of a temper, but it ain't nothin' compared with the young feller I put off at Ithaca."

* * *

"You admit you drove over this man with a loaded truck?"

"Yes, your honor."

"Well, what have you to say in your defense?"

"I didn't know it was loaded."

* * *

He: "Why wait until we get home before you tell me if you'll marry me or not?"

She: "I'm scared. This is the very spot where my father proposed to my mother."

He: "So what?"

She: "Well, on the way home the horses ran away and father was killed."